Engineering Library

DEC 9 1929

The Engineer.

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VOL. CXLVIII.—No. 3854] LONDON: FRIDAY EVENING, NOVEMBER 22, 1929 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director-General, India Store Department, Belvedere-road, Lambeth, London, S.E. 1, invites TENDERS for :—
8330 AXLE-BOXES FOR CARRIAGES AND WAGONS.
Tenders due Friday, 3rd January, 1930.
Forms of Tender available from the above at a fee of 5s., which will not be returned. 3792

Crown Agents for the COLONIES.
COLONIAL GOVERNMENT APPOINTMENTS.
APPLICATIONS from qualified candidates are INVITED for the following POST :—
M/1869.—ASSISTANT ENGINEER REQUIRED by the GOVERNMENT of IRAQ for the IRRIGATION DEPARTMENT for two years' probationary service, with the possibility of an extended contract for 10 years. Salary Rs. 650 a month, rising by annual increments of Rs. 50 a month. Free passages out and home again on satisfactory termination of agreement. Candidates, unmarried, 23 to 26 years of age, must have passed Sections "A" and "B" of the A.M.I.C.E. examinations or hold professional qualifications recognised by the Institution of Civil Engineers as exempting those examinations. Should have had one or two years' useful experience since taking their degrees, preferably in (a) Mechanical Excavation, and (b) Well Boring. An advanced knowledge of Mathematics and Physics which could be applied to hydraulic research is also desired.
Apply at once by letter, stating age, whether married or single, and full particulars of qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W.1, quoting M/1869. 3800

Armourers' and Brasiers' COMPANY.
LECTURES IN METALLURGY.
The Company have arranged for the following LECTURES to be delivered :—
At the Royal School of Mines, Prince Consort-road, South Kensington, S.W., at 6 p.m. on 20th and 27th November and 4th December, 1929, by Professor SIR HAROLD CARPENTER, F.R.S., M.A., on
"SINGLE CRYSTALS OF METALS AND ALLOYS—THEIR PRODUCTION AND PROPERTIES."
At the Northampton Polytechnic Institute, St. John-street, Clerkenwell, E.C., at 7 p.m. on 27th November and 4th and 11th December, 1929, by Dr. H. J. GOUGH, M.B.E., D.Sc., Ph.D., on
"THE STRENGTH OF METALS IN THE LIGHT OF MODERN RESEARCH."
Admission free, without ticket. 3742

Borough Polytechnic Institute, BOROUGH-ROAD, LONDON, S.E. 1.
HEAD OF DEPARTMENT OF MECHANICAL AND STRUCTURAL ENGINEERING AND BUILDING.
The Governors invite APPLICATIONS for the above-named APPOINTMENT, rendered vacant by the promotion of the present holder to a Principalship. Subject to the agreement of the London County Council, the post will be graded as a Class I. Head of Department, with a salary scale £675-£25-£830. Full-time service is required. Particulars of the appointment and form of application may be obtained by sending stamped addressed foolscap envelope to the undersigned.
J. W. BISPHAM, Principal.
3769

University of Leeds.
DEPARTMENT OF ENGINEERING.
APPLICATIONS are INVITED for the APPOINTMENT of DEMONSTRATOR in CIVIL and MECHANICAL ENGINEERING. Salary £300 a year. Duties to commence early in January.—Particulars may be obtained from the REGISTRAR, The University, Leeds, who will receive applications up to the 2nd December. 3761

University of the Witwatersrand, JOHANNESBURG.
DEPARTMENT OF PHYSICS.
LECTURE ASSISTANT.
REQUIRED for February, 1930, or as soon thereafter as possible, LECTURE ASSISTANT, who must be experienced in the handling of general physical apparatus; preference will be given to applicants who have experience in Glass Blowing or Workshop Practice.
Salary £248-£26 10s. £354 per annum, subject to Provident Fund contributions. Half salary will be paid from date of embarkation to date of arrival in Johannesburg.
Transport, third-class steamer fare and second-class railway fare, will be allowed, subject to proportionate refund in the event of resignation within two years.
Applications, together with copies of testimonials, all in triplicate, should reach the SECRETARY, the Office of the High Commissioner for the Union of South Africa, South Africa House, Trafalgar-square, W.C. 2 (from whom form of applications and further particulars may be obtained)), not later than 6th December, 1929. 3766

Bombay, Baroda and Central INDIA RAILWAY CO.
The Directors are prepared to receive up to Noon on Wednesday, 11th December, TENDERS for the SUPPLY of :—
1. HELICAL AND VOLUTE SPRINGS.
2. TYRES FOR LOCOMOTIVES.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 10s. each (which will not be returned).
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG, Secretary.
Offices : The White Mansion, 91, Petty France, Westminster, S.W. 1, 19th November, 1929. 3794

The Engineer

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PUBLIC NOTICES

County Borough of Southampton.
TO CONTRACTORS AND OTHERS.
The Corporation invite TENDERS for the LAYING and JOINTING of about 10,200 YARDS of 15in. C.I. SOCKET and SPIGOT WATER MAIN from Yew Hill Reservoir, Compton, to the junction of Stoneham-road with the Southampton-Winchester Road, North Stoneham.
Plans may be seen and specification, bill of quantities and form of Tender obtained at the Waterworks Offices, 21, Shirley-road, Southampton, upon production of the Borough Treasurer's receipt for a deposit of £3 3s. Deposits will be returned after the Council have dealt with the Tenders to contractors who have submitted bona fide Tenders.
Sealed Tenders, endorsed "15in. Water Main, Yew Hill to North Stoneham," on the prescribed form, together with priced quantities and schedule, must be delivered at the Town Clerk's Office, Southampton, on or before the 12th December, 1929.
No pledge is given to accept the lowest or any Tender.
R. RONALD H. MEGGESON, Town Clerk.
15th November, 1929. 3765

County Borough of Southampton.
CAST IRON PIPES AND SPECIAL CASTINGS.
The Corporation invite TENDERS for the SUPPLY and DELIVERY of about 10,200 LINEAL YARDS of 15in. C.I. SOCKET and SPIGOT PIPES and about 30 TONS of SPECIAL CASTINGS.
Specification, schedule and form of Tender may be obtained at the Waterworks Offices, 21, Shirley-road, Southampton.
Sealed Tenders, endorsed "Tender for 15in. Pipes and Specials," must be delivered at the Town Clerk's Office, Southampton, on or before Ten o'clock in the forenoon of the 12th December, 1929.
Tenders from British manufacturers only will be considered.
No pledge is given to accept the lowest or any Tender.
R. RONALD H. MEGGESON, Town Clerk.
15th November, 1929. 3764

PUBLIC NOTICES

City of Nottingham.
WATER DEPARTMENT.
PIPE LAYING.
UNEMPLOYMENT RELIEF SCHEMES.
The Water Committee invite TENDERS from competent firms for LAYING and JOINTING about 6230 YARDS of 18in. CAST IRON MAIN in the City of Nottingham and Parishes of Beeston and Bramcote; 780 YARDS of 15in. and 690 YARDS of 12in. CAST IRON MAINS in the Parish of Bramcote; and 1780 YARDS of 9in. CAST IRON MAIN in the Parishes of Bramcote and Chilwell, together with necessary VALVES, HYDRANTS, CONNECTIONS, &c.
Plans, conditions of contract, specification, bill of quantities, schedule and form of Tender may be obtained from Mr. F. W. Davies, Engineer and General Manager, Water Department, Castle Boulevard, Nottingham. Each application must be accompanied by a cheque for Five Guineas, which will be refunded on receipt of a bona fide Tender and the return of all documents.
Sealed Tenders, endorsed "Tender for Pipe Laying," must be delivered to me at my office not later than Monday, the 2nd December, 1929.
W. J. BOARD, Town Clerk.
Guildhall, Nottingham, 15th November, 1929. 3763

Egyptian Government.
TENDERS are called for by the Mechanical Department, Ministry of Public Works, for the SUPPLY and ERECTION of HIGH-TENSION THREE-PHASE OVERHEAD TRANSMISSION LINES in the Northern Delta of the Nile.
Tenders should be submitted DIRECT to the DIRECTOR-GENERAL, Mechanical and Electrical Department, Ministry of Public Works, Cairo, not later than Noon on the 27th February, 1930.
Copies of the necessary conditions of Tender, specifications and drawings, &c., can be obtained on application to the Chief Inspecting Engineer, Egyptian Government, 41, Tothill-street, S.W. 1, against remittance of £10 5s. per set, which sum is not returnable. Copies of these documents are also available for scrutiny at the above address.
Firms on the Continent should apply to the Egyptian Consulate in their respective countries for the above-mentioned documents. 3778

PUBLIC NOTICES

Staffordshire Potteries Water BOARD.
PIPE LAYING.
The Board is prepared to receive TENDERS for EXCAVATING TRENCHES for and LAYING about 6 MILES of CAST IRON PIPES, 16in. to 24in. diameter.
Specification and schedule of quantities may be obtained at my office on payment of £5 in banknotes, which will be returned on receipt of bona fide Tender and documents supplied.
Tenders, to be endorsed "Pipe Trenches" and addressed to "Chairman, Staffordshire Potteries Water Board, Albion-street, Hanley, Stoke-on-Trent," must be received not later than Tuesday, 10th December.
The Board does not bind itself to accept the lowest or any Tender.
R. C. FRAIN, M. Inst. C.E., Engineer and General Manager.
Albion-street, Hanley, Stoke-on-Trent, November, 1929. 3762

Uxbridge Urban District COUNCIL.
SALE OF MACHINERY.
The Council invite TENDERS for the PURCHASE of :—
30 H.P. COMPOUND VERTICAL SURFACE CONDENSING STEAM ENGINE, with Fly-wheel and Crank Shaft, Governor, Gauges, Oil and Grease Separators and Condenser, &c., by Goddard, Massey and Warner, as fixed at Waterworks, Uxbridge, Middlesex.
Worthington Type DOUBLE-THROW FEED PUMP, by Mumford, with 3in. Steel Feed Pipes, as fixed.
SET of 8in. diameter THREE-THROW PUMPS, with Crank Shaft with Helical Drive, Gun-metal Barrels, Buckets and Rods, Brass Bearings, Flanged Iron Suction, Stand Pipes and Rising Main, &c., as removed from Well.
Particulars to be obtained from Council's Surveyor, Mr. Wm. L. Eves, 54, High-street, Uxbridge.
Tenders, endorsed "Tender, Engine and Pumps," to be sent to the undersigned not later than Twelve o'clock Noon on the 12th day of December, 1929.
H. M. BLACKWELL, Clerk.
Council Offices, "Southfield," High-street, Uxbridge. 3786

West Ham Union.
The Guardians invite TENDERS for the WORK of INSTALLING a FIRE ALARM SYSTEM at their Whipps Cross Hospital, Whipps Cross-road, Leytonstone, E. 11.
Specification and form of Tender will be forwarded on application to the undersigned, and Tenders must be delivered not later than 10 a.m. on Thursday, the 28th November, 1929.
L. E. FRAQUET, Clerk to the Guardians.
Board Room, Union-road, Leytonstone, E. 11, 14th November, 1929. 3736

Metropolitan Water Board.
APPOINTMENT OF (A) TWO TEMPORARY ENGINEERING ASSISTANTS, AND (B) A TEMPORARY JUNIOR ASSISTANT IN THE ENGINEERING DRAWING-OFFICE.
The Metropolitan Water Board invite APPLICATIONS from those who are students of the Institution of Civil Engineers or who have passed an examination qualifying for studentship, in respect of the APPOINTMENT of TWO TEMPORARY JUNIOR ENGINEERING ASSISTANTS. APPLICATIONS are also INVITED for the APPOINTMENT of a TEMPORARY JUNIOR ASSISTANT in the Engineering Drawing-office. The appointments will be in the Department of the Chief Engineer, at an inclusive salary of £6 per week in each case.
Applications, in the candidates' own handwriting, stating age and full particulars of training and qualifications, should be addressed to Mr. Henry E. Stilgoe, M. Inst. C.E., the Chief Engineer, and must reach the offices of the Board not later than the 2nd December, 1929.
Canvassing will be held to be a disqualification.
G. F. STRINGER, Clerk of the Board.
Offices of the Board, 173, Rosebery avenue, E.C. 1, 14th November, 1929. 3767

Required for Important British-owned Railway in Argentina :—
STRUCTURAL STEEL WORK DRAUGHTSMAN, with thorough practical knowledge of Structural Details of all classes.
TWO DRAUGHTSMEN, with thorough knowledge of Calculation and Design of Bridge Abutments and Retaining Walls in Brick or Mass Concrete. Preferably with knowledge of Design of Armoured Concrete Railway Structures, and must be capable of preparing working drawings and quantities.
Salary on 3 years' agreement, £400, rising to £500 p.a. Free passages.
Reply, stating age, if single or married, and full details of training and experience, with copies (only) of testimonials, to Box L.A.B., c/o Davies and Co., 95, Bishopsgate, London, E.C. 2. 3799

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PUBLIC NOTICES

South Staffordshire Water-WORKS COMPANY.
CIVIL ENGINEERING DEPARTMENT.

APPLICATIONS are INVITED for the APPOINTMENT of SECOND CIVIL ENGINEERING ASSISTANT.

Candidates must have had considerable experience in the design and maintenance of important waterworks, including impounding reservoirs, reinforced concrete service reservoirs, detection of waste, distribution and up-to-date administration of large waterworks undertakings.

Applicants must be corporate members of the Institution of Civil Engineers, having had responsible experience with a water company or Water Department of a Public Authority.

Commencing salary £500 per annum, which is subject to deductions under the Company's Superannuation Scheme.

Applications, stating age, details of education, training, qualifications and particulars of experience, accompanied by copies (only) of three recent testimonials, endorsed "Civil Engineering Assistant," must be addressed and delivered to the undersigned not later than the 27th November, 1929.

FRED. J. DIXON, M. Inst. C.E.,
Engineer-in-Chief.

14th November, 1929.
Engineer's Office,
26A, Paradise-street, Birmingham. 3741

Southwark Union.
ENGINEER'S FITTER.

The Guardians of the above-named Union invite APPLICATIONS before Noon on Monday, 2nd December, 1929, for the APPOINTMENT of a competent ENGINEER'S FITTER (with experience of Turning, Boilers, Engines, Laundry Machinery, Central Heating, Electric Lighting and Electric Lifts), at their Hospital, East Dulwich-grove, S.E. 22.

Salary at the rate of £4 10s. per week, together with working overalls.

The appointment is subject to the provisions of the Poor Law Officers' Superannuation Act, 1896.

Forms of application will be forwarded upon receipt of a stamped, addressed, foolscap envelope.

By Order,
A. P. STANWELL SMITH,
Clerk to the Guardians.

Union Offices:
50/51, Ufford-street,
Blackfriars-road, S.E. 1.
19th November, 1929. 3795

Walsall and West Bromwich
UNIONS JOINT COMMITTEE.
GREAT BARR PARK COLONY.

WANTED, a thoroughly competent WORKING ENGINEER at the above Colony.

Candidates must have had previous experience in taking charge of Steam Plant and Electric Light Installation and be a fully competent Millwright and able to do all necessary repairs and to maintain Boilers, Pumps, Laundry, Motors, Heating Service, and Electric Light in thorough working order.

Wages £4 per week.

The successful candidate will be required to reside in a modern house on the estate; rent 6s. per week plus rates.

The appointment is subject to the provisions of the Poor Law Officers' Superannuation Act.

Application form may be obtained from me, for which a stamped foolscap envelope should be sent. Completed application forms must be received by me not later than 10 a.m. on Monday, the 2nd December, 1929.

Canvassing members of the Committee is strictly prohibited.

By Order,
A. H. WARD,
Clerk.

22, Lombard street, West Bromwich.
14th November, 1929. 3759

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

RE ADVERT. Box No. 3596, for TECHNICAL ENGINEERING CORRESPONDENT.—Have to advise that VACANCY has now been FILLED. 3801 A

WANTED, ASSISTANT SUPERINTENDENT for large works engaged on light mass production. Successful executive experience as well as good practical knowledge of tools and methods necessary.—Address reply, 3725, The Engineer Office. 3725 A

WANTED by Messrs. LEVER BROTHERS, Port Sunlight, an ASSISTANT to the MANAGER of the BUILDING and REPAIR DEPARTMENT. Applicant must have full experience of the building trades, both management of office and work on the site. Position requires full experience of factory maintenance, road construction and railway track, also the erection of reinforced concrete and steel-framed buildings. Applicant must have full experience of pricing and be able to prepare estimates, also be of good physique.

State age, whether married or single, and salary required. Only those with a character which will bear the strictest investigation should apply, with copies of testimonials, to be addressed "Private, Engineering Appointment," LEVER BROTHERS, Limited, Port Sunlight. 3722 A

WANTED, COST CLERK for East Coast Shipbuilding and Engineering Works. Only experienced applicants need apply. State full particulars and wages required.—CRABTREE and CO. (R. H. Hutchinson), Great Yarmouth. 3816 A

WANTED, ENGINEER, with Experience of Drawing-office work, also good knowledge of Powdered Fuel and Heavy Grinding Machinery.—Address, P6415, The Engineer Office. P6415 A

WANTED for an Indian Chemical Works:—
1. THREE SHIFT MANAGERS who can take control of the running of a Chemical Plant.
2. ONE ELECTRICAL ENGINEER, to take charge of the Electrical Generating Plant, Motors, &c.
3. ONE MECHANICAL ENGINEER, to take charge of the Boilers and Steam Plant and the Mechanical Section of the Factory.

Age of applicants about 30 to 40. The Shift Managers must have had experience in Chemical Works. Any candidates wishing to apply for any of these vacancies must state age, general qualifications for the work and approximate indication of salary required, when they will receive fuller particulars. Address, 3808, The Engineer Office. 3808 A

WANTED, for Work in the Middle East, a MECHANICAL ENGINEER, below 28 years of age, single, with Degree in Engineering, and preferably some Industrial or Research experience. Particulars, with copies (not originals) of testimonials, &c.—Address, 3811, The Engineer Office. 3811 A

WANTED, Well-educated WORKS MANAGER for works of 400 hands. Up-to-date experience, control of men (indoor and outdoor) essential. A man of about 40 years of age with tact and initiative would find this an advancing position. Replies treated in strictest confidence.—Address, 3714, The Engineer Office. 3714 A

A RESEARCH ENGINEER is REQUIRED for Experiments upon the Largest All-metal Aircraft Structures. Candidates should possess a good Engineering Degree with special experience in the mathematical investigation of highly redundant structures. Preference will be given to candidates with Wind Channel experience and with experience of the Electrical Equipment of Large Aircraft. Commencing salary £500.—Address, 3768, The Engineer Office. 3768 A

YARROW HOME and HOSPITAL
FOR CHILDREN
BROADSTAIRS.

For the Early & Preventive Treatment of Disease & Convalescence after illness.

In these days of high cost of living, people of limited means are sometimes placed in a difficulty when their children are ill or need operations and afterwards require a change of air and much careful attention during convalescence. It cannot be too well known that the Yarrow Home and Hospital for Children, Broadstairs, Kent, was founded specially for the children of those who are not too well endowed with this world's goods. At this Home a child recovering from illness or an operation, or needing a long course of medical or surgical treatment, receives, amid the happiest possible surroundings and companionship, careful nursing and attention, such as could ordinarily only be obtained at expensive nursing homes. There are beds for fifty boys between the ages of four and twelve years, and for fifty girls between the ages of four and fourteen years. In special cases these age limits may be exceeded by two years. The fee is one guinea per week and travelling expenses. Applications for the entrance of patients are welcomed from professional people, such as members of the Institution of Civil Engineers, architects, artists, authors, clergymen, members of the medical, legal, and other professions, members of scientific societies, officers of the Navy, Army, and Royal Air Force, officers of the merchant navy, school masters, university professors, &c. The London office is at 116, Victoria-street, Westminster, and the Secretary will be pleased to send full particulars to anyone who is interested.

SITUATIONS OPEN (continued)

ALLOYED STEELS.—Well-known MANUFACTURERS REQUIRE a TECHNICAL REPRESENTATIVE (SALESMAN) for Midlands, with thorough knowledge of modern Alloyed Tool Steels. The post is an important one for suitable man. Candidates are invited to send full particulars of their qualifications.—Address, P6416, The Engineer Office. P6416 A

ASSISTANT REQUIRED for Plant Layout Department of Commercial Motor Factory.—Apply, stating experience, age, and salary required, to EMPLOYMENT DEPARTMENT, Morris Commercial Cars, Ltd., Soho, Birmingham. 3760 A

ENGINEER REQUIRED, with First-class Manufacturing experience, preferably specialist in Labour-saving and Mechanical Handling Appliances. American or German experience an advantage. State full particulars of experience, age, and salary required. —Address, 3773, The Engineer Office. 3773 A

EXPERIENCED SURVEYOR for Brazil. Accustomed Forest and Swamp Work. Must speak Portuguese. State experience, age, salary required.—"H.," Box 755, Owen's Advertising Agency, 133-6, High Holborn, W.C. 1. 3817 A

LOCOMOTIVE ENGINEER REQUIRED for appointment Service Engineer in Argentine. Must have running experience. Age not over 30.—Address, giving full particulars, experience, 3728, The Engineer Office. 3728 A

LONDON REPRESENTATIVE.
We REQUIRE First-class MACHINE TOOL MAN of long experience for London district.
Please address applications, with full details as to experience and salary required, to E. H. JONES (MACHINE TOOLS), Ltd., Britannia Wharf, Baldwin-terrace, London, N. 1. P6427 A

MECHANICAL ENGINEER REQUIRED, with Locomotive and preferably Power-house experience for permanent appointment in Australia; age about 32.—Address, giving full particulars, experience, &c., 3729, The Engineer Office. 3729 A

REFRIGERATION AND COLD STORAGE.—Young MAN, with practical knowledge of above trades, good education and address, WANTED.—Address, P6384, The Engineer Office. P6384 A

REQUIRED on Contractor's Side, Young CHARTERED CIVIL ENGINEER, with knowledge of Outside Work and Estimating, mainly for London office.—Apply by letter, stating experience, age, salary required, &c., to INDUSTRIAL CONSTRUCTIONS, Ltd., 54, Victoria-street, Westminster, S.W. 1. 3806 A

REQUIRED Shortly, GENERAL MANAGER for Railway in Spain. Traffic training and fluent Spanish absolutely essential.—Write, giving experience, testimonials, to "W. D.," c/o Streets, 6, Gracechurch-street, London, E.C. 3. 3770 A

TRAVELLERS REQUIRED, Having Sound Connection amongst all users of Black Bituminous Paint. Commission basis.—Write fully, Box 508, Sells Advertising Offices Fleet-street, E.C. 4. 3796 A

WANTED, First-class CRANE DRAUGHTSMAN, with varied experience.—Address, stating age, experience, and salary required, 3812, The Engineer Office. 3812 A

WANTED IMMEDIATELY, TWO Capable DRAUGHTSMEN (over 25 years of age). Must have experience in detailing Steel Bridge and Roof Work.—Applications, stating age, experience, and salary required, to FRANCIS MORTON and CO., Ltd., Hamilton Ironworks, Garston, Liverpool. 3721 A

WANTED, SENIOR DRAUGHTSMAN, with Machine Tool experience, for Midlands. State full experience, age, and salary required. Also JUNIOR or IMPROVER, accustomed to Small Tools and Jigs.—Address, 3807, The Engineer Office. 3807 A

WANTED, Skilled DRAUGHTSMAN, for Yorkshire, who understands the Hydraulic Press Trade. Good and permanent position to right man. One who is accustomed to Calculating and Estimating preferred. State age, experience and wages required. —Address, 3787, The Engineer Office. 3787 A

CRANE DRAUGHTSMAN in Midlands. Capable man with sound experience in designing Jib Cranes and with good knowledge of Structural Work. Permanency for right man. State age, experience, and salary.—Address, 3798, The Engineer Office. 3798 A

DRAUGHTSMAN, First-class Designer, for Machinery similar to Textile and Dyeing. Good opening for suitable man. State age, experience, wages.—Address, 3772, The Engineer Office. 3772 A

DRAUGHTSMAN REQUIRED by Large Engineering Firm in Lancashire, with wide experience of Instrument and Meter Work.—Address, with particulars of age, training, experience, and salary required, 3529, The Engineer Office. 3529 A

DRAUGHTSMAN REQUIRED, Experienced in Carbonising Plant and Coal Handling. Progressive position.—Address, stating age, experience, and salary required, P6422, The Engineer Office. P6422 A

DRAUGHTSMAN REQUIRED for English Firm of Structural Engineers in Calcutta, with good knowledge of both Light and Heavy Work and, if possible, of Estimating. Good prospects. Unmarried. Age about 25.—Apply in writing, with full particulars of experience, to Z.E. 541, care Deacon's Advertising Agency, Fenchurch-avenue, London, E.C.3. 3776 A

DRAUGHTSMEN REQUIRED, with Thorough Experience in the design and layout of Plant for Large Steel Works.—Reply, giving full particulars of past experience, age, and salary required, to ENGINEER'S DEPARTMENT, P.O. Box No. 57, Sheffield. 3814 A

SITUATIONS OPEN (continued)

DRAUGHTSMEN, Senior, Having Sound Experience of Electric Control and Contactor Gear.—Address applications, stating age, experience, and salary required, with copies of references, 3661, The Engineer Office. 3661 A

DRAUGHTSMAN, SENIOR, WANTED IMMEDIATELY for South of England for Material Handling Plants, capable of taking charge of complete contracts. DETAILERS also WANTED.—Write, stating age, experience, and salary required, to Box 493, Sells Advertising Offices, Fleet-street, E.C. 4. 3753 A

DRAUGHTSMAN WANTED for Light Mechanical and Large Clockwork; S.E. London.—Address, stating age, experience, &c., 3758, The Engineer Office. 3758 A

EXPERIENCED WORKS DRAUGHTSMAN REQUIRED for Metallurgical Works in South Wales now carrying out alterations and additions to plant.—Address, stating experience, salary, and age, 3774, The Engineer Office. 3774 A

JUNIOR DRAUGHTSMAN, Able to Make Detail and Arrangement Drawings, REQUIRED IMMEDIATELY; must be quick and accurate. Good prospects.—Address, giving experience, age, and salary required, P6424, The Engineer Office. P6424 A

MECHANICAL DRAUGHTSMAN REQUIRED IMMEDIATELY for Compressor Work only.—Address, giving particulars of experience, &c., 3779, The Engineer Office. 3779 A

MECHANICAL DRAUGHTSMAN REQUIRED (London district). State age, salary, and experience. —Address, 3780, The Engineer Office. 3780 A

QUALIFIED MECHANICAL DRAUGHTSMEN REQUIRED, used to fine accurate work.—Write, giving particulars of past employment, age, and salary required, to Box 148, Advertising Offices, 84, Queen Victoria-street, London, E.C. 4. 3777 A

SENIOR DRAUGHTSMAN REQUIRED for a South Wales Works. Previous Rolling Mill experience an advantage.—Address, stating experience, age, and salary required, 3802, The Engineer Office. 3802 A

SENIOR DRAUGHTSMAN WANTED for London office. Must have first-class experience in preparation of schemes for Mechanical Handling Equipment.—Address, stating age, experience, and salary expected, 3803, The Engineer Office. 3803 A

STRUCTURAL DESIGNER, First-class Man, REQUIRED for South of England.—Write, stating age, experience, and salary required, to Box 492, Sells Advertising Offices, Fleet-street, E.C. 4. 3752 A

WANTED, FOREMAN DIE SINKER, with Experience in Machining and Sinking Large Dies. One with knowledge of the Keller Die Sinker preferred, age 35/45.—Address, stating full experience and wage required, 3813, The Engineer Office. 3813 A

FOREMAN REQUIRED by Large Firm Manufacturing Electrical Machinery. Applicants must have had wide experience and possess considerable organising ability. Preference given to man with transformer shop experience. State full particulars.—Address, 3726, The Engineer Office. 3726 A

PATTERNMAKERS (Engineers). Permanency.—Apply, PERCY J. SMITH, 2a, Wynyatt-street, London, E.C. 1. 3675 A

SITUATIONS WANTED

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For continuation of Small Advertisements see page 4.

A Seven-Day Journal

New French Warships.

THE French naval programme for 1930, which was submitted to the Chamber on November 15th, provides for the construction of eighteen vessels, viz., one 10,000-ton cruiser, six destroyers, six first-class submarines, one minelaying submarine, one surface minelayer, two sloops, and one net-laying vessel. The total tonnage of the ships is 48,000, and the estimated cost £10,136,000. The new cruiser will be the seventh unit of the 10,000-ton class to be built for the French Navy. Her immediate predecessor, the "Dupleix," was begun at Brest early this month. The six destroyers will be of the "Vauban" type, displacing about 2700 tons and armed with six 5·5in. guns. They will be, in fact, large flotilla leaders, combining very high speed with good sea-keeping qualities and a wide radius of action. The six submarines belong to the "Redoubtable" class, which, including those now projected, comprises thirty-one boats, all of 1550 tons surface displacement, a speed of 18 knots, and a radius of 8000 miles. The submarine minelayer is to be of the "Saphir" type, 780 tons and 12 knots, carrying thirty-two mines in addition to torpedo tubes. She will be the sixth boat of this group. Details of the new surface minelayer are not available, but she is expected to duplicate the "Pluton," launched last April, which is a ship of 5300 tons, with a speed of 30 knots. The two sloops are designed for Colonial service, and are of light draught to enable them to navigate rivers. The displacement is 2000 tons, the machinery consists of two internal combustion engines developing 3000 b.h.p., and the maximum speed is 15½ knots. At 10 knots the cruising endurance will be 9000 miles. The armament includes three 5·5in. guns and four anti-aircraft guns. A seaplane is carried on board. It is proposed to build twelve of these useful vessels at an estimated cost of £300,000 per ship. The submarine cruiser "Surcouf," which was begun at Cherbourg two years ago, was launched on Monday, November 18th. With a surface displacement of 3257 tons and a length of 400ft., she is, by a considerable margin, the largest submersible vessel in existence. The designed speed is 19 knots on the surface and 10 to 11 knots when the vessel is submerged. At a cruising speed of 9 to 10 knots the fuel supply carried will give the vessel a radius of action of from 10,000 to 12,000 miles. She will be equipped with two guns and will carry thirty torpedoes, the tubes for which will be arranged to permit several to be discharged simultaneously.

Expenditure on Electricity Schemes.

WITH the concurrence of the Minister of Transport, the Electricity Commissioners have issued a circular letter dealing with schemes for the relief of unemployment. On July 18th, the Lord Privy Seal and the Minister of Transport met representatives of the electricity supply industry to discuss methods by which the amount of employment provided by the industry could be increased in order to assist the Government in dealing with the problem of unemployment. The time that has elapsed since that meeting, the circular letter explains, has not perhaps been sufficient to allow schemes on any considerable scale to be prepared and approved by undertakers, but the Commissioners trust that before the end of the year they will be able to report that they have before them evidence of a substantial increase in the activities of the industry, for they are confident that the supply industry as a whole is in a position to make an important contribution towards the solution of the problem of dealing with the unemployed. It appears that the annual capital investment in the transmission and distribution systems has grown from under £8,000,000 in 1922–1923 to over £16,000,000 in 1927–1928, and if expenditure continues to increase, the outlay during the next five years should be over £100,000,000. The Commissioners are of opinion that the expenditure of a considerable percentage of this sum could be accelerated so as to fall within the next two years without throwing an unreasonable burden on the industry. The view of the Commissioners is that it is proper to lay mains in any street in which there is a reasonable prospect that within the next few years the annual revenue will defray the actual additional outgoings.

The World's Fastest Lifeboat.

AT the Hampton Launch Works of John I. Thornycroft and Co., Ltd., at Platts Eyot, Hampton-on-Thames, there was launched yesterday, November 21st, the world's fastest and largest lifeboat. The ceremony was performed by the Hon. Mrs. Sempill, wife of Colonel the Master of Sempill. The new boat, which has been built to the order of the Royal National Lifeboat Institution, will be stationed at Dover and has been specially designed to serve the needs of the heavy cross-Channel passenger traffic and to go to the aid of any aeroplane which may come down at sea. She has a length of 64ft. and is equipped with two cabins. Wireless telephones of the Marconi type are fitted. Her propelling machinery comprises a twin-screw arrangement of Thornycroft "Y 12" petrol motors. The twelve cylinders of each engine are arranged in two groups of six, arranged in "V" form, and the designed output of each engine is 375 b.h.p. Each cylinder has a bore of 5¾in., with a stroke of 7in., and the running speed is from 1500 r.p.m. to 1650 r.p.m. The propellers are coupled directly to the engines, and fuel tanks are provided which will give a cruising radius of about 100 miles. The speed of the boat will be from 17 to 18 knots, which is considered to be the fastest speed obtainable without having to sacrifice the essential qualities of a lifeboat. The motor lifeboats which are at present stationed on the South Coast have twin engines each of 80 b.h.p., and a speed of 10 knots. There are many interesting features in the new boat, and Messrs. Thornycroft are to be congratulated on producing a design which will extend further the scope of the work of the Royal National Lifeboat Institution.

The Shipyard Joiners Lock-out Averted.

WE are pleased to record that after somewhat lengthy negotiations at the Ministry of Labour, on Tuesday a settlement of the dispute between the Shipbuilding Employers' Federation and the Amalgamated Society of Woodworkers was reached, which will avert the general lock-out of shipyard joiners referred to in our issue of November 8th. Work is to be resumed at Belfast as soon as yard arrangements permit, and the lock-out notices are to be withdrawn. The Amalgamated Society of Woodworkers has accepted the national uniform time rate of 60s., which rate will apply from the beginning of 1930. As from the date of the resumption of work at Belfast the plain time rate of 60s. 9d. per week will be increased to 62s. 3d., including 10s. bonus, this rate applying only to the Belfast members of the Amalgamated Society of Woodworkers. In so far as this rate is in excess of the national uniform time rate of 60s., which is to come into operation at the beginning of 1930, such excess is to be merged in any future national wages advances. The Amalgamated Society of Woodworkers has also agreed to withdraw the embargo on overtime, and the Employers' Federation, with that union and the whole of the other shipyard trade unions, will investigate any grievances which may arise in the operation of the overtime agreement. Meanwhile, without prejudicing the notice with respect to overtime which was given by the Amalgamated Society of Woodworkers in August, 1928, the members of that society are to resume overtime and night shifts, on the same basis as the other trade unions in the industry. The settlement of the seven months' dispute at Belfast will be greatly welcomed by the owners of ships under construction in Belfast yards, the delivery of which has been seriously delayed. It is a little over a week ago since Sir Horace Wilson, on behalf of the Minister of Labour, intervened in the dispute and interviewed both parties. Sir Horace presided at Tuesday's meeting when the settlement was reached.

Prolonged Flight by R 101.

AT 10.35 on Sunday morning the airship "R 101" left Cardington mooring tower with thirty-four people on board for a flight of indefinite duration. Flying by way of the East Coast she passed across Scotland from Edinburgh to Glasgow, and proceeded down the Firth of Clyde to Belfast. Turning, she crossed by way of the Isle of Man to Blackpool, where she again turned and crossed to Dublin. Turning for a third time she proceeded across to Holyhead and thence flew by way of Chester back to Cardington, which she reached at 4.25 p.m. on Monday. The flight had lasted 30 hours, and when the vessel returned to the tower she had still sufficient fuel on board for a further flight of 36 hours. During the trip the average cruising speed was about 60 miles an hour. The weather was difficult. At times winds up to 25 m.p.h. were encountered, and during part of the trip fog prevailed and hid the land from sight. Satisfactory turning trials at various speeds were carried out during the flight, and in all respects the vessel is stated to have behaved splendidly.

Fuel Economy on Board Ships.

IT is understood that the United States Shipping Board will shortly consider a proposal to create a private undertaking in order to continue the work which has been done by the Fuel Conservation Committee in promoting fuel economy in the ships of the Shipping Board fleet. The Fuel Conservation Committee has adopted the plan of creating a roll of honour and an honourable mention list for the masters and the chief engineers of vessels which show the best results over a period of six months' voyages. In order to qualify for the £10 bonus offered to the masters and the chief engineers, a vessel must have made voyages totalling 20,000 miles in the six months and the combined sea and port efficiency of the ship must be better than, or equal to, 95 per cent. of that of the leading vessel in her class. Total savings of more than £200,000 were shown by the vessels in the Shipping Board fleet in 1928, as compared with the 1922 records of the same ships. In the latter half of 1928 there was a gain in savings of about £44,400, as compared with the first half of the year. With a private undertaking it is hoped that by charging a reasonable fee for all vessels taking part in the scheme, and by carrying on an educational campaign in the engineering departments of the various participating lines, further economies in fuel may be effected. It may be recalled that the head of the Fuel Conservation Committee of the Shipping Board is Mr. C. J. Jefferson, who gave a paper on pulverised fuel progress at the recent meetings of the Institute of Fuel.

The Geographical Distribution of Industry.

EACH year the Ministry of Labour prepares a census of the industrial population insured against unemployment and analyses the figures with respect to the distribution of that population geographically and by trades. For the insurance year 1928–29 the census for which has just been published, the figures imply that there has been a continuation of the southward trend of industry, which has been indicated in previous years. The southern section of England is that part of the country south of a line drawn westwards from the Wash to include Cambridgeshire, Nottinghamshire, Derbyshire, and Staffordshire. This area in July, 1929, contained, according to the Ministry's figures, 48 per cent. of the insured industrial population, as compared with 45·7 per cent. in 1923. In the rest of England, Scotland, Wales and Northern Ireland, there is now 52 per cent. of the industrial population, as compared with 54·3 per cent. in 1923. Since 1923 the insured industrial population for the whole of Great Britain and Ireland has increased by 8 per cent. In the southern section the increase has been 13·5 per cent., and in the rest of the country only 3·4 per cent. To get down to absolute figures, it may be added that during the last two years the insured industrial population in the southern section increased by 261,000, and in the rest of the country by only 40,000. Close examination shows that there has been a greater increase in the insured industrial population in the area lying to the east of a line drawn from the Wash to Portsmouth—the south-eastern division—than in the rest of the southern district, and, indeed, than in any other division of the country. In the south-eastern division there is now concentrated 26 per cent. of the insured industrial population, as compared with 25·7 per cent. in 1928 and 24·2 per cent. in 1923. If this steady trend continues it will soon be a fiction to speak of "the industrial north." The implication of the Ministry's figures is no doubt open to discussion in certain respects, but that the increasing industrialisation of the south is an actual fact, can scarcely be disputed by anyone in a position to note the extent to which factories are being established in or transferred to the areas surrounding London.

An Empire Marketing Scheme.

PARTICULARS have been published this week of a comprehensive scheme, prepared, as the result of five years' preliminary development, by Agricultural and General Engineers, Ltd., of London, for the world marketing of agricultural engineering products. Nearly 75 per cent. of the world's trade in agricultural machinery is done in two classes of product, the tractor and the harvester. British agricultural engineers have only recently begun to manufacture these two classes of implement, and as a consequence Britain's trade in agricultural machinery is valued at only about two millions sterling per annum, or about 7 to 8 per cent. of the total world trade, excluding that of the United States. The A.G.E. Company has now taken steps to remedy this position. It has entered into an agreement with the Rushton Tractor Company, Ltd., of Walthamstow, to handle, in addition to its own products, the sales of Rushton tractors in all the principal markets of the world, and with H. V. McKay Proprietary, Ltd., of Sunshine, Melbourne, to handle the sales of Sunshine harvesting machinery in South America. The Australian Company has already built up a large trade for its harvesting machinery, and is convinced that under the new arrangement it will be able to increase its share of the important South American market for harvesters. For markets other than the South American, the A.G.E. Company contemplates manufacturing harvesting machinery in this country. The Rushton tractor, see page 558, an entirely British manufactured machine, was placed on the market last April, and, it is claimed, has already shown that it can compete in efficiency and economy with any other tractor. The A.G.E. Company already has, or will shortly have, branches in Argentina, Chile, South Africa, India, Australia, and New Zealand. The organisation which has been built up is stated to be suitable for the handling not only of the products directly covered by the agreements, but those of other British firms making anything from a split pin to a bridge. The company is prepared to consider favourably on broad and equitable principles applications from firms for representation in any of the markets named.

The Grimsel Hydro-Electric Power Scheme.

By Captain G. MACLEOD ROSS, M.C., M. Eng., A.M. Inst. C.E., R.E.

In order to meet annually increasing demands for electric power, the Forces Motrices Bernoises S.A. (F.M.B.) began some two and a-half years ago the construction of an hydro-electric power scheme in the Aar Valley through the agency of the Kraftwerke Oberhasli A.G.

The scheme comprises a main reservoir at the Grimsel, connecting to an auxiliary reservoir and

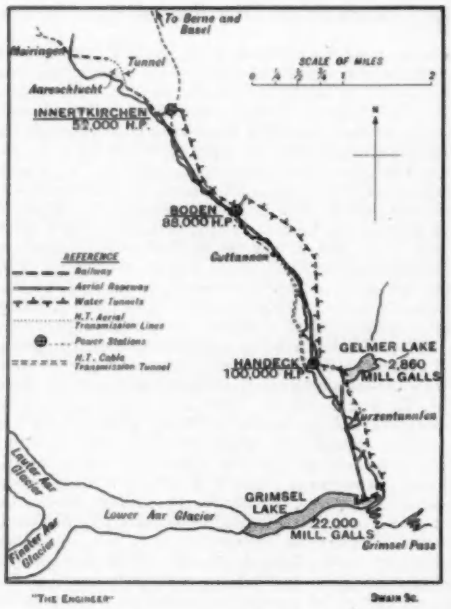


FIG. 1

catchment area at Gelmer, from which three power stations utilise the water in turn, the stations being sited at gradually descending levels down the Haslithal—as shown in Figs. 1 and 2.

When the first stage of the work is completed in 1932, the annual output will amount to 223 million kWh, from an installed power of 100,000 H.P. The final development will produce 538 million kWh, with 240,000 H.P. installed.

Since 1920 a committee of experts has been busy examining every aspect of this scheme. Measurements of the flow of water from the upper Aar basin for ten years—1914–1923—indicate that the annual flow into the main Grimsel reservoir will be 52,800 million gallons, whilst the Gelmer catchment area is estimated to collect some 18,700 million gallons annually. The committee included amongst its number a geologist, and although he was generally satisfied as to the homogeneity of the granite at the site proposed for the main dam—the Spitallamm—nevertheless, a gallery was driven under the Aar across the Spitallamm gorge in order to confirm his predictions. As a result of all this investigation and measurement, no doubt remains as to either the favourable nature of the geological conditions or as to the adequacy of the water supply.

The Grimsel Works.

The Grimselsee, the main reservoir of some 22,000 million gallons, which is being formed at a height of 6200ft. above sea level, is reached from Meiringen, where the railway ends, by a road winding and twisting upwards through the picturesque Haslithal. By means of two comparatively small dams, for the location is ideal from an hydro-electric point of view, a lake 3 miles long and ½ mile broad is to be formed, stretching from the old Hospice, which will soon be submerged, right up to the ice of the lower Aar glacier—Figs. 3 and 4. When completed, the high water level of this artificial lake will stand at 6271ft., whilst its mean depth will be 270ft.

The two dams are the Spitallamm and the Seeuferegg. The former—Fig. 5—377ft. high, which blocks a gorge of solid granite 590ft. wide at the top of the dam, is of the arch type, and contains 444,720 cubic yards of concrete. The upstream face slopes at 10 to 1, the downstream face at 2 to 1. The latter dam—Fig. 7—is a straight wall of gravity section, 1000ft. long at the crown, which will carry the new roadway leading up to the recently completed Hospice situated on the local hillock called the Nollen, which separates the two dams—see Fig. 4. The Seeuferegg dam contains 75,864 cubic yards of concrete. This dam is nearing completion, whilst the Spitallamm dam is already some 164ft. high.

During the six months, May to October, available for work at these inclement altitudes, continuous shifts are employed, and the flow of concrete into the dam never ceases.

Perched 500ft. up on the side of the Nollen is a huge steel-framed and wood-sided building, with several storeys extending down the rock face on the Spitallamm side—Fig. 8, page 552. At the north-eastern end of the building there are two large cement silos, which are supplied by aerial ropeway from Innertkirchen, 12½ miles, and 4000ft. lower, down the valley.

The cable skips carry 1000 lb. of cement apiece; they take two hours to do the trip up from Innertkirchen, and some 500 arrive daily. Over 10,000 tons of cement had already been delivered by this ropeway to the Grimsel site. Next to the cement silos are the stone-breaking and sifting machinery, under which are three huge bins, into which sand and graded stone falls. The aggregate is all hauled over three miles of contractors' double-track railway line from the foot of the Aar glacier to the base of the Nollen, whence

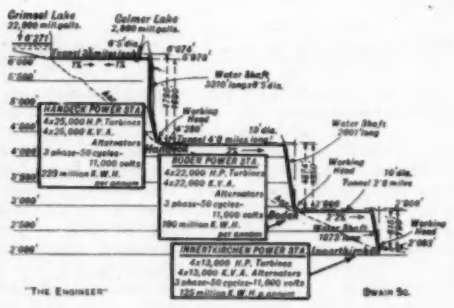


FIG. 2

it is elevated to the top storey of the building to be crushed.

On the south side of this building there is an enormous pile of shingle and stones which is being collected for use in the final stages of construction of the Spitallamm dam when the present source of supply is submerged, for it is intended to commence immediately impounding water up to a level of some 150ft. on this dam, so that the generation of current at Handeck may be started. As the construction of this dam progresses, the water level will be gradually raised, and consequently the bed of the Aar river, from which all the aggregate is at present being loaded, will be submerged.

The aggregate bins feed belt conveyors on to which the correct proportions of aggregate and cement are measured out and carried to batteries of concrete mixers, which, in turn, feed a large variety of grabs running on aerial cableways spanning the Spitallamm gorge or discharge direct into a large steel chute suspended 500ft. above the bed of the Aar down which a torrent of concrete flows unceasingly.

Occasionally the flow into this chute is checked by a large stone becoming wedged at an elbow, and immediately and until the supply can be checked, a hail of stones and slush falls 200ft., sometimes on to the heads of the men directing the placing of concrete on the dam itself. Many casualties have resulted, and a watchman with a horn is employed to warn the men controlling the supply from the concrete mixers.

Apart from this main chute, the five or more skips, which contain 4 cubic yards of concrete each, are continually plying out and down to the required point on the dam, depositing their loads into chutes. By these combined means some 3700 cubic yards of concrete are placed daily. The whole of the plant is electrically driven from power supplied from a temporary hydro-electric station.

It took three years of preparation, collecting materials and erecting plant before any work on these dams could be begun. During this time a new line of narrow gauge railway was tunnelled out between Meiringen and Innertkirchen, as the famous Aareschlucht or Aar gorge has to be negotiated, and twelve and a-half miles of aerial ropeway had to be erected from Innertkirchen to the Grimsel site and also from

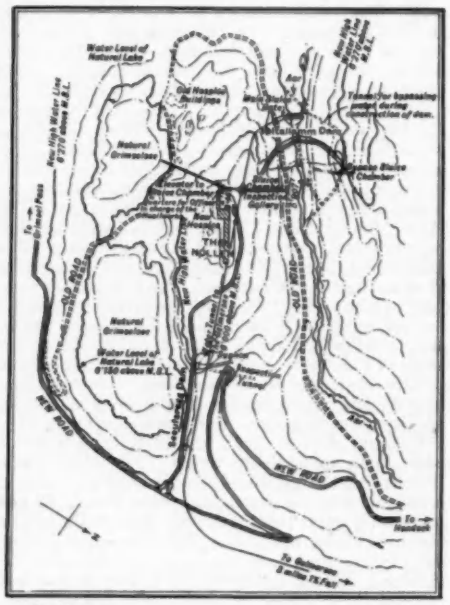


FIG. 4

Kurzentannlen to the Gelmersee. All this was done, and work continues to-day, under serious climatic handicaps, in a region where fog, rain and low temperature are ever present. The labour, which is half Italian and half Swiss, is housed in the new Hospice. There are only 800 men on the Grimsel site now; last year 1500 and in 1927 2000 being engaged.

It is a most inspiring sight to stand on the old road on the west side of the Nollen and to look down on to the dam, whose broad base is being so freely sprayed with concrete; then to look up to the network of swaying cables which carry travelling skips and support the great gutter. Across on the bare face of the granite is seen the profile of the completed dam hacked out of the rock, so that the concrete may key in. At the sight of these splaying lines out on the hillside—see left side of Figs. 5 and 6—all sense of proportion is lost until the gaze fastens on a wooden ladder rearing its head from the dam top right up to the cable anchorages, blasted out 300ft. higher up, and a tiny ant-like figure is seen to be perilously ascending.

The Grimselsee works are exhilarating because they spell such a wonderful triumph over the forces of Nature. The site is ideally chosen; maximum result for minimum effort. The organisation of the

FIG. 3—MODEL OF THE SPITALLAMM DAM, THE NOLLEN AND THE SEEUFEREGG DAM

construction is perfect; smooth continuous flow of material to one nodal point, mixing and subsequent flow on to the work. A complete absence of bottlenecks; a surprising absence of supervision, everyone doing his job as though he enjoyed it. Altogether, a wonderful tonic when the whole is set in an atmosphere of Alpine air and blue gentians.

The Gelmer Works.

The next step in this great scheme is the Gelmer Lake, 2½ miles lower down the valley and connected with the Grimselsee by a 6½ft. diameter tunnel, 3¼ miles long, hewn out of the granite with the aid of compressed air and blasting gelatine. Here another dam, 1250ft. long and containing 102,000 cubic yards of reinforced concrete, is practically complete, forming a reservoir of 2860 million gallons capacity—Fig. 9, page 552.

The dam raises the water level of the natural Gelmer Lake by some 100ft. to a height of 6074ft. above sea level and some 200ft. below the level of the Grimsel reservoir. Theoretically, it would have been simpler to make the levels in these two lakes the same, but natural conditions are not so ideal at Gelmer, and the cost of raising the water level at Gelmer to 6270ft. would be double the cost of attaining this water level at Grimsel, where natural conditions are so favourable.

From the Gelmer Lake the water falls sheer some 1750ft. in a 6½ft. diameter steel shaft, 3310ft. long, on to four turbines in the power station at Handeck. This shaft is subterranean, and therefore free from all danger from avalanches, &c.

Gelmersee is practically right on top of Handeck, and, in addition to its connection to the Grimselsee, it is fed by streams and glaciers in the vicinity. It is reached from Handeck from a point just above the beautiful Handeck Falls, by a funicular railway, which rises 1700ft. up the perpendicular face of the rock, carrying a load of sixty men at a time up the steepest railway in Switzerland, the last portion being vertical. The view from the higher reaches of this railway is magnificent, and no doubt in time a trip up this funicular will provide a much-favoured thrill for the public at large.

Handeck Power Station.

The site for the Handeck power station—Fig. 10—has been chosen on a short wooded length of the Aar valley, where avalanches are not prevalent. The power station is a fine steel-frame building, with faced granite panels, and is served by a 90-ton travelling crane. The doors are pressed steel and slide vertically on balance weights. Owing to the severity of the winter, the adjoining living quarters are connected to the power station by tunnel.

The quantity of water utilised at the Handeck station to meet the average demand for power will be 235 cusecs, whilst the maximum demand will, it is estimated, increase this figure to 425 cusecs. As this station is capable of utilising from 590 to 616 cusecs, depending on the water level of the Gelmer Lake, one of the four units installed in the power station can be looked upon as a reserve.

In the station will be housed four Oerlikon Pelton turbines of 30,000 H.P. each, running at 500 r.p.m. on a vertical axle, above which will be mounted three-phase, 50-cycle alternators of 25,000 kVA each, generating at 11,000 volts. Two units have already been completed and will be in operation shortly. Opposite each generator is its transformer, which transforms the current up to 50,000 volts. A feature of these transformers is that they can be removed from position on special motor-driven bogies for repair or inspection, complete with all their cooling apparatus, with a minimum of trouble.

The alternators are ventilated by a specially designed system which permits of the supply of cool air in summer and warm air in winter, whilst in case of fire, ventilation automatically ceases and carbon dioxide stored in bottles under pressure is liberated into the sealed ventilating ducts to extinguish the fire.

The switchboard, apart from the usual electrical measuring instruments, contains a gauge showing the water level on the Gelmersee, and by means of a series of press buttons the temperature in various parts of the station can be ascertained on a master gauge. Controls are also provided so that the water supply at the Grimselsee and at Gelmer may be shut off in case of accident to machinery at Handeck.

Against each generator are a number of temperature alarms, together with a press-button system, whereby the temperature of the main bearings may be ascertained as required. A feature of the turbine-room is the huge wall and cast steel bearing to take the thrust of the column of water from the Gelmersee.

The current from each generator after transformation to 50,000 v. at Handeck, is carried separately to Innertkirchen, 7½ miles away. The first three miles of this distance are, however, very liable to avalanches, and as it was considered unsafe to rely on the normal aerial transmission standards, it was decided to build a tunnel from Handeck to Guttannen (3478ft. above M.S.L.), in the floor of which the high-tension cables are buried.

After a few hours have been spent on the inspection of this great undertaking, it is realised that the Swiss engineer will tunnel through granite at the slightest provocation. This particular tunnel has been made large enough to contain a small battery-driven locomotive and train on which material can be brought up to Handeck from Guttannen under any climatic conditions.

All the plant for this Handeck power station has to be transported along hill roads on motor lorries and trailers. The biggest piece handled consists of one-half of the rotor which weighs 22 tons.

Innertkirchen.

At Innertkirchen is situated an open-air transformer station, and four sets of lines from Handeck are led in to 4/26,000-kVA Brown-Boveri transformers, by which the voltage is stepped up to 150,000. The current from all the generators is paralleled at this station, from which the line of high-tension transmission towers starts on its way over the Brunig Pass for Berne and Basle. A feature of this transformer station is a motor-driven rail trolley on to which any transformer can be rolled for removal for repair.

Final Development.

The full scheme includes a second generating station at Boden—already built—wherein four 22,000 H.P. turbines will be installed, producing 190 million kWh per annum. The head of water at Boden will be 1360ft.

The third station at Innertkirchen, to which the water will finally be conducted by tunnel, awaits four 13,000 H.P. turbines working under a head of 800ft., and generating 125 million kWh per annum.

Financial Aspect.

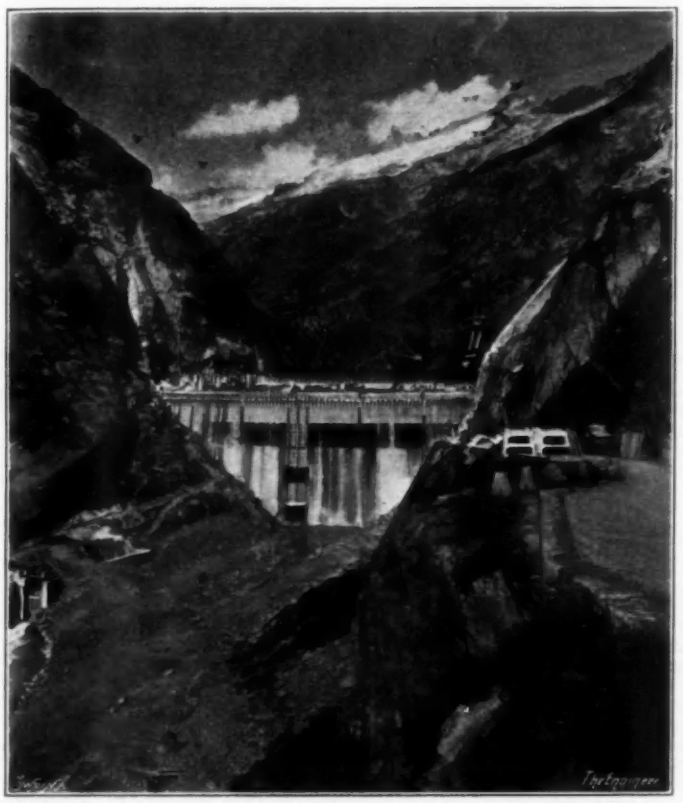
Finally, the estimated cost of this wonderful piece of work is set down as £3·3 millions, with annual running costs, interest, amortisation, and reserves at 8·83 per cent. of this figure. The net cost of current on the basis of the 223 million kWh produced annually by the Hendeck station alone is expected to be ·352d. per unit, but it is hoped when the full scheme is complete to reduce the net cost to ·238d. per unit.

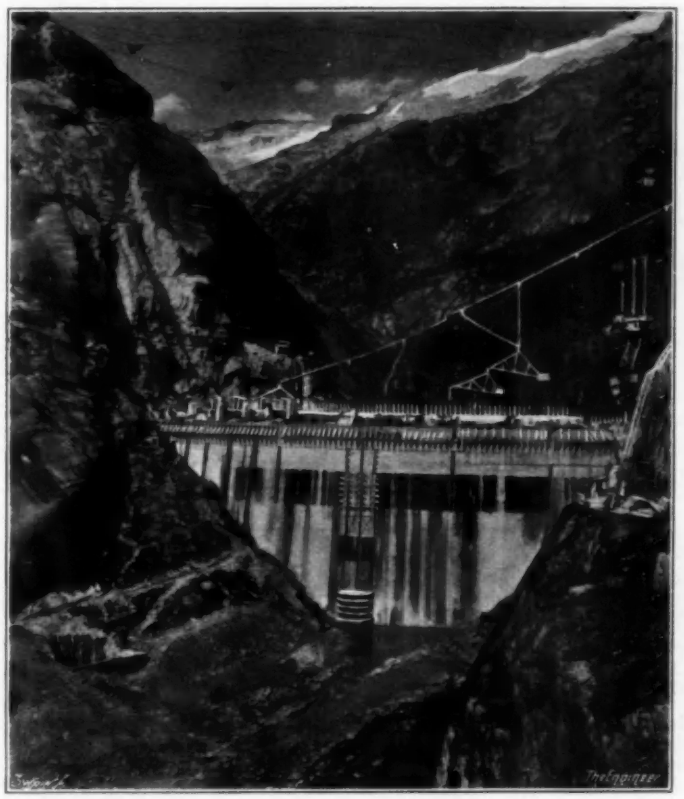
It is perhaps of interest to compare these costs with those for the Shannon scheme:—

	Grimsel partial scheme.	Shannon partial scheme.
Capital cost, million pounds ..	3·3 ..	8
Annual charges, per cent. capital	8·85 ..	8·75
Cost per kWh generated, part scheme, pence	·352 ..	1·13
Power generated per annum, million kWh	223 ..	147½

* * * *

Acknowledgements are due to the Kraftwerke Oberhasli A.G. for its courtesy in authorising this visit; to Monsieur Hauck, engineer in charge at Handeck power station, for the time and trouble he took to explain his charge; to Sir W. Tindall Lister, K.C.M.G., for permission to reproduce Figs. 5, 6 and 7; to Libraire F. Rouge et Cie, Lausanne, for Fig. 3; and to Kunstanstalt Brügger A.G., of Meiringen, for Fig. 8; the remaining illustrations are copyright by the author.





Figs. 5 and 6—The Spitallamm Dam in August, 1929

A Note on Superheating and Locomotive Cylinder Efficiency.

By E. L. Diamond, B.Sc. (Eng.), Assoc. M. Inst. C.E., A.M.I. Mech. E.

Some time ago the writer published an analysis* of the cylinder losses in a three-cylinder standard compound locomotive of the London, Midland and Scottish Railway based on a series of indicator diagrams taken during dynamometer car tests on regular service. Whilst such an analysis can, in the present absence of exact data on this subject, give most useful information, it was carefully pointed out at the time that in the absence of a direct and continuous measurement of the net steam consumption

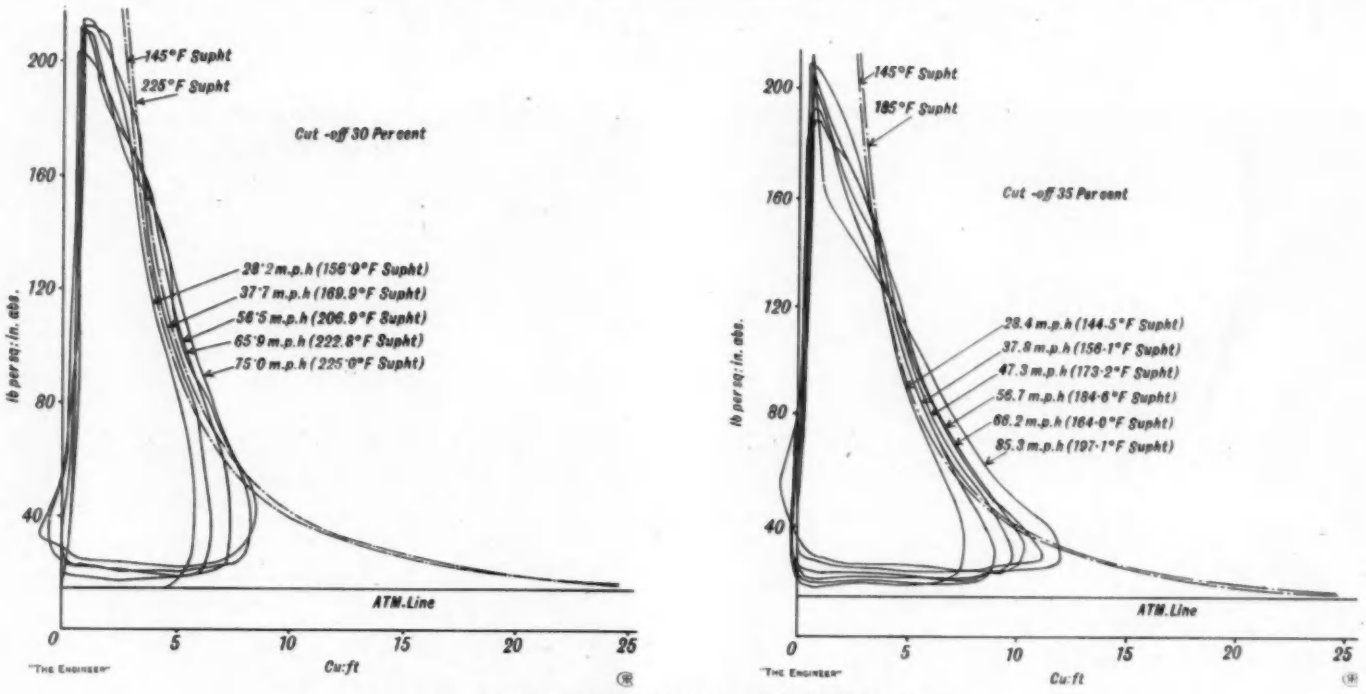
* "Proc.," I. Mech. E., 1927, Vol. I., page 465.

of the locomotive the value of such an analysis, so far as most of the cylinder losses are concerned, is confined to the examination of their proportions relative to the useful work done, whilst in the case of the loss due to steam and heat leakage and condensation nothing more than an approximate estimate of its average magnitude over the whole range of running conditions is possible.

At the present time there is, so far as the writer is aware, no published information of a detailed character as to the exact behaviour of the steam in a locomotive cylinder under varying running conditions. The nearest approach to the kind of information needed was an analysis contributed by Mr. Lawford Fry† to the discussion on the writer's paper and subsequently incorporated in a paper of his own. In this analysis a careful attempt was made to estimate the heat quantities exchanged in the high-pressure cylinder of a Baldwin compound locomotive during cycles at varying speeds and cut-offs, but the method adopted, though perhaps more precise than an examination of the disposition of the indicator diagrams within the adiabatic expansion lines, did not permit of any investigation of the low-pressure cycle. The real function of any analysis of this type, however, is to give guidance to the locomotive designer in fixing the dimensions of the steam ports and exhaust passages and the proportions of the valve gear, and for this purpose some indication of the total losses occurring through the whole cycle from admission to exhaust is probably of greater value than an exact knowledge of the heat distribution during a limited period of the cycle. It is also suggested that important conclusions can be drawn regarding the most economical degree of superheat to be employed if some attempt is made to examine the behaviour of the steam throughout its expansion.

With this in mind, and hoping also to gain some information as to the validity of the assumptions and allowances made in his earlier paper, the writer has reconstructed quantitatively two series of indicator diagrams taken at the Pennsylvania Railroad Company's locomotive testing plant at Altoona. Sufficient data are given in some of the published bulletins to enable this to be done, though the absence of information as to clearance volume renders others of little value for this purpose. The two series relate respectively to the E6S 4–4–2 superheater locomotive‡ and the K4S 4–6–2 superheater locomotive.§ Simple-expansion locomotives were necessarily chosen, but the work involved in reconstructing the diagrams, in any case somewhat laborious, was thereby reduced. It might be remarked at this stage that the reason why the very detailed analyses which have been published from time to time for stationary engines are of little comparative value is that, apart from other obvious differences of working conditions, the essential feature of the locomotive engine is its wide range of operating conditions. To determine the losses with the utmost accuracy from a single diagram would be of very limited value. Efficiency at a speed of 30 m.p.h. might easily be gained at the expense of efficiency at 70 m.p.h.

Figs. 1 and 2 show the two sets of diagrams, the individual diagrams in each case being superimposed on each other. In both series the cut-off was constant and the speed was varied through a wide range. More useful information can be obtained under such conditions than by varying the cut-off at constant speed, though the exclusion of other sets of conditions was necessary in order to keep the work within limits. The cut-offs, though slightly different in the two cases, represent normal conditions of working. It should be noticed that when comparing the expansion lines of the successive diagrams the varying degree of superheat at admission must be taken into account. Table I. sets forth the conditions for each diagram and gives the percentages of the various cylinder losses as measured by the corresponding areas on the diagrams and in terms of the useful work done. The boiler pressure for both locomotives was nearly constant at 205 lb. per square inch gauge.



FIGS. 1 AND 2—SUPERIMPOSED INDICATOR DIAGRAMS

TABLE I.—*Particulars of Tests.*

Locomotive	E6S.					K4S.					
Test number	2802	2803	2811	2812	2822	4017	4021	4026	4059	4033	4058
Speed, m.p.h.	28·2	37·7	56·5	65·9	75·0	28·4	37·8	47·3	56·7	66·2	85·3
Speed, r.p.m.	120	160	240	280	320	120	160	200	240	280	360
Superheat, deg. Fah.	156·9	169·9	206·9	222·8	225·0	144·5	156·1	173·2	184·6	164·0	197·1
Cut-off, per cent.	30	30	30	30	30	35	35	35	35	35	35
Cylinder feed, lb. per stroke	0·726	0·649	0·557	0·516	0·485	0·955	0·799	0·713	0·656	0·597	0·492
Cylinder efficiency,* per cent.	59·9	61·4	65·9	65·0	70·5	72·1	74·0	74·5	74·1	75·1	71·4
Throttling at admission, per cent.	2·05	2·68	6·41	7·1	4·3	4·65	7·6	6·8	8·65	8·7	17·6
Incomplete expansion, per cent.	40·4	31·6	20·5	16·0	13·4	17·3	11·8	7·5	6·5	3·5	2·1
Back pressure, per cent.	0	8·15	12·3	14·7	15·3	10·5	10·8	14·2	16·0	21·9	24·2

* Measured from the reconstructed indicator diagrams.

The outstanding feature of the two sets of diagrams is that at all but the lowest speeds the expansion lines lie outside the adiabatic for the same weight of steam at the same initial superheat. That is to say, throttling at admission when the engine is running at speed imparts to the steam a greater degree of superheat than it originally possessed, and it appears to retain this until it commences to leave the cylinder. In some cases the increase appears to be very large, but the uncertain effects of clearance, &c., make it unwise to draw detailed conclusions. Direct measurements of the steam temperature at exhaust do not show this increase of superheat, for in the most extreme case, namely, the K4S diagram at 85 m.p.h. (360 r.p.m.), the exhaust superheat was not more than 50·2 deg. Fah. This, however, can be accounted for, since the exhaust passages may be at a lower temperature than the cylinder bores and a considerable cooling effect is therefore likely to occur immediately after release of the steam. The variation of the exhaust superheat corresponds closely with the conditions shown by the diagrams.

Now, the primary economy of superheating in locomotives is known to be due to the elimination of cylinder condensation, which may cause a loss of as much as 25 per cent. of the work done in saturated steam locomotives. The theoretical gain from the use of superheated steam is otherwise comparatively small, and the question arises whether under the circumstances represented by these diagrams a high degree of superheat is justified. Clearly, when running under the normal conditions for which such express locomotives were designed, the degree of superheat was in these cases more than sufficient to eliminate condensation and the greater proportion of the excess is lost at release. It is significant to note that the thermal efficiency of both locomotives actually decreased with increase of superheat, although it was always far higher than the efficiency of corresponding saturated steam locomotives. Such a state of affairs, of course, is quite contrary to expectations, but is accounted for by the fact that the higher degrees of superheat corresponded to higher rates of evaporation and therefore lower boiler efficiency. Nevertheless it confirms the suggestion that once condensation has been overcome, further increase of superheat can only bring a relatively small improvement in efficiency.

The importance of this conclusion will be evident to the practical locomotive engineer. In recent express locomotive designs in which the boiler dimensions have approached the permissible limit it has been found difficult to obtain the same degree of superheat as in smaller locomotives, and some concern on this account has been expressed. Nevertheless the performance of these locomotives does not seem to have suffered on this account. On the other hand, there is the case of the Great Western Railway, in which a much lower degree of superheat than is usual practice in this country has been consistently employed, and so far from having any adverse effect, this fact has not prevented certain of this company's designs from representing a kind of standard of locomotive efficiency. There are many practical difficulties associated with high steam temperatures. These were never more clearly apparent than during the period of oil-burning following the coal strike of 1926, when, owing to the effect of the unevenly distributed flame, excessively high degrees of superheat were obtained in many locomotives and a great deal of trouble was thereby caused.

The writer therefore suggests that it would at least be worth while, in the light of the facts disclosed by these diagrams, to discover just how locomotive efficiency does vary with superheat. Such an investigation would necessitate stationary plant tests with separate locomotives of the same type having different superheaters, because it is essential, of course, that other conditions should be constant. It is probable that the curve of increase of efficiency with increase of superheat would be found to rise rapidly at first and then, commencing at a well-defined point, to continue to rise very gradually. And it is suggested that it might well prove to be uneconomical, when costs of maintenance are taken into consideration, to design the superheater so as to give a much greater degree of superheat than corresponds to this critical point. It might be added that, in the case of goods locomotives, it would probably prove to be desirable to design for a higher degree of superheat than in

† *Ibid.*, page 493; and Vol. II., page 923.

‡ *Bulletin* No. 21, 1913. See also Mr. E. C. Poultney's summary of the E6S tests, THE ENGINEER, 1929, vol. 148, pages 6 and 44.

§ *Bulletin* No. 29, 1915.

the case of express locomotives, since the effect of throttling at admission will not be so important.

The present tendency to increase steam temperatures in stationary steam plant beyond the maximum obtained in ordinary locomotive practice is scarcely relevant to this problem. As long as the locomotive designer is compelled by the exigencies of running sheds and loading gauges to use such devices as the radial valve gear and the blast-pipe it is idle for him merely to imitate the high flights of the modern turbine designer.

To return to the consideration of Figs. 1 and 2, it must be remarked that the considerable increase of superheat during expansion shown in most of the diagrams was unexpected and has no parallel in the set of diagrams published for the L.M.S. compound

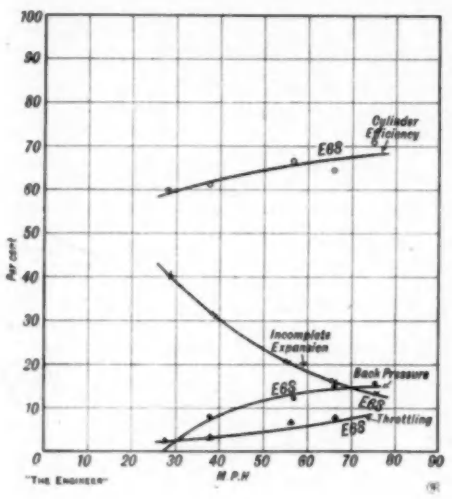


FIG. 3

locomotive. The writer has already pointed out‖ that stationary plant tests favour the attainment of maximum steady cylinder temperatures, and this must partly account for the difference. There is also the possibility, since the engine had been in regular service for some time, that steam leakage was appreciably greater in the case of the L.M.S. compound, especially as the low-pressure cylinders were operated by slide valves. Probably, however, the method of averaging the steam consumption during a long and varied journey, which was unavoidable in the case of the English compound locomotive, adversely affected its apparent cylinder efficiency, though, of course, the main result of the original paper, which was a comparison of the relative proportions of the various

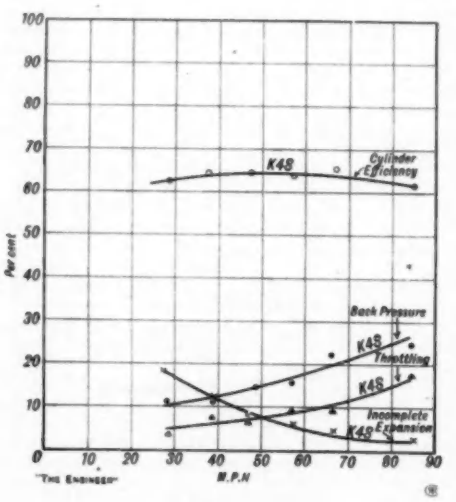


FIG. 4

cylinder losses under varying conditions, is in no way qualified.

In conclusion, a brief reference may be made to the losses due to incomplete expansion, throttling, and back pressure. These are plotted in Figs. 3 and 4 from the figures given in Table I. The last two losses are, of course, considerably lower than in the case of the L.M.S. compound, and far lower than in the case of many British simple-expansion locomotives. The American engines, however, have a 7in. valve travel and little more is required by way of explanation. The back pressure loss in the case of the E6S locomotive is astonishingly small and serves to show that a high back pressure is by no means excused by the supposed necessity for a strong blast. Incidentally, it should be pointed out that this low back pressure, even as compared with the K4S, is partly accountable for the apparently greater loss due to incomplete expansion, since the latter was in every case measured down to the back pressure. It is noteworthy also that the loss due to incomplete expansion in the case of the K4S is no greater than that of the L.M.S. compound, thus showing that the cylinder performance of a compound without the advantage of good valve events may be easily equalled by that of a well-designed simple expansion locomotive working at a short or moderate cut-off. It would be interesting, however, to compare with the K4S the cylinder performance of one of the French Nord compounds.

‖ "Proc.," I. Mech. E., 1927, Vol. II., page 981.

Institution of Mechanical Engineers

THE paper on "Journal Bearing Practice," by Mr. Francis Hodgkinson, of Philadelphia—reprinted in full elsewhere in this issue—which was presented at last Friday's meeting of the Institution of Mechanical Engineers in London, produced a very good discussion. There was on the whole little adverse criticism of the author's statements and opinions, but practically without exception, those who spoke contributed fresh and interesting information on the important subject with which the paper dealt.

Mr. H. L. Guy informed the meeting that Mr. Hodgkinson was British born and was still a British subject. He was, Mr. Guy continued, a prolific inventor, had been one of the pioneers in the development of high-speed machinery, and had been directly responsible for the design and construction of over 10,000,000 kilowatts capacity of steam turbines. His paper, Mr. Guy continued, was welcome because public discussion on the subject of bearings and lubrication had suffered in the past from the reticence of those who had been closely associated with the development of high-speed machinery. Fifteen years or so ago turbine designers had generally accepted the rule in dealing with bearings that the product of the pressure in pounds per square inch on the bearings multiplied by the speed of the journal in feet per second should be constant, and in general equal to 2500. That rule had long ago been exploded by the mathematician and the experimentalist, and was now properly regarded as being archaic. For what it was worth, the product P V had now reached values as high as 22,000. For example, his firm had built machines running at 3000 r.p.m., for which P = 113 and V = 131, and other machines running at 1500 r.p.m., for which the values were P = 136 and V = 105. They were now building a large machine running at 3000 r.p.m., for which P would have the value 138, and V would be 157. It was historically interesting to note that as P had increased with V in passing from 2500 to 22,000, journal bearings had become increasingly satisfactory and trustworthy, and to-day they gave rise to no operating difficulties whatever. Some of the changes which had accompanied the transition from low to high values of the P V constant were of much interest. Whereas in the early days bearings were commonly made two to three diameters in length they were now often less than one diameter long. Formerly bearings were bedded to the journals; to-day, they were rarely bedded, but were merely bored to a diameter larger than the journal by about 0·002in. per inch diameter. It had been found that if the bearings of a high-speed machine were bedded to the journals over an arc exceeding 60°, vibration could be set up which was indistinguishable from that caused by the rotors being out of balance. The increased clearances now adopted were, in his opinion, merely a convenient way of providing an adequate channel for the escape of the large proportion of the oil which had to be supplied simply as a heat carrier, and not as a lubricant. In bearings of the early type attempts were made to control the admission and distribution of the oil by generous oil grooves of intricate pattern. In modern bearings the load-carrying surfaces were unbroken by grooves of any kind. Whereas at one time bearings were commonly spherically supported they were now supported rigidly, semi-rigidly, or elastically. At one time the bearing shells were made of bronze or brass, and were usually lined with lead base white metal. To-day the shells were of cast iron or steel, and were lined with tin-base metal. At one time great attention was paid to the oil pressure at the bearings. To-day chief concern attached to the quantity of oil passing through the bearings and its exit temperature. Formerly, the oil used had a Redwood viscosity of about 250 seconds at 100 deg. Fah. The oil now used had a viscosity of only about half that amount, or, say, 130 seconds at the same temperature.

Observations and experiments made on the low-speed, lightly loaded bearings which represented general practice at the time, led Mr. Guy and his firm to certain conclusions, which, he stated, had governed the subsequent developments which he had just indicated. Measurements of the quantity of oil supplied and of its temperature rise often indicated a frictional loss of at least twice the amount expected from Summerfeld's modifications of Reynolds' analysis. The conclusion reached was that the oil film thickness was sensibly less than was generally supposed, and that the reduction of thickness arose from the concentration of pressure towards the centre of the length of the bearing, and the elastic deformation of the shell which that concentration produced. Further distortion of the bearing, it was concluded, was produced by the temperature gradients along the length of the shell and radially through its thickness, and possibly also as a result of the different coefficients of expansion of the white metal lining and of the shell material. It was found that by hollowing out the lining towards the centre of the bearing before it was applied to the journal, the changes in form arising at normal temperature and under normal load could be compensated for and that the observed frictional loss could be reduced from over twice the "theoretical" value down to, or below, the theoretical value. This practice was, however, too complex for general adoption, but as an outcome it led to the stiffening of the bearing shells and a shortening of their length.

The author, Mr. Guy said in conclusion, had stated that the temperature of bearings should be below 140 deg. Fah. That limit was applicable in temperate climates, but in tropical countries temperatures of 150 deg. to 160 deg. could be run to without harmful results. The desire to have the bearings cool to the touch, corresponding, say, to a temperature of 100 deg., gave rise really to the waste of a large amount of coal. In a power-house in which five 30,000-kW machines were installed, a waste of coal representing, when capitalised, a sum of £8000, might readily be incurred by the fad of running the bearings at 120 deg. instead of at 140 deg.*

Mr. H. M. Martin said that the author had given some valuable data as to present limits of surface speeds and bearing pressures. In the case of the turbine at Hell Gate, the low-pressure bearings had a surface speed of 124ft. per second, and the load was 174 lb. per square inch of the projected area of the journal. These figures agreed closely with those given in the paper. On the other hand, the surface speed of the high-pressure bearings was 140ft. per second, and a turbine was now under construction in this country in which the surface speed would be 170ft. per second. Fifteen years ago a surface speed of 33ft. a second was considered high. Even then, however, those conversant with the theory of lubrication felt assured that much higher speeds must be practicable; but in the earlier attempts to increase the speed temperatures rose alarmingly. The secret of success lay, as the author pointed out, in realising that much more oil must be supplied for cooling purposes than was needed for lubrication. With imperfect lubrication the process of bedding in brasses was no doubt advantageous; but, as ordinarily carried out, it gave the brass the same radius as the journal. With full lubrication, however, theory showed that the brass should be of greater diameter than the journal. The plan described in the paper of scraping the brass to fit a mandrel a little larger than the diameter of the journal seemed to be a very good one; but, as the author pointed out, in normal conditions scraping was unnecessary. It was, however, not always easy to persuade the shopmen to abandon their traditional procedure.

In his paper the author, Mr. Martin continued, gave 2 mils per inch as the allowance for the difference in diameters of brasses and journals. Some turbine builders allowed twice as much, but there had then been occasional cases of vibration on starting up the turbine, as a result of the journals climbing from their positions of rest to their running positions. They climbed in a succession of starts followed by slipping back, until a certain limit of speed was reached. Mr. Hodgkinson's experiments on the lower limit of running speed were of interest in this connection. While with over-liberal clearances there might be cases of vibration, too small clearances caused a pressure to be developed between the journal and the top brass, thus increasing friction and heating. This fact was proved experimentally by Dr. Lasche. From the quantitative standpoint, the theory of the journal bearing was much less satisfactory than that of the

* Mr. Guy's detailed calculations on this point are as follows:
Maximum continuous rating of turbine, 41,000 kW.
H.P. + L.P. thrust bearing loss at 140 deg. Fah. = 0·155 per cent. of M.C. rating.
Turbine H.P. + L.P. journal bearings at 140 deg. Fah. = 0·231 per cent.
Total loss at 140 deg. Fah. in turbine journal thrust bearing = 0·386 per cent.
The friction work varies as $\sqrt{\mu}$, where μ = viscosity; and the viscosity μ varies as $\frac{1}{(T-32\text{ deg.})^3}$, where T = temperature in deg. Fah.
The friction work therefore varies as $\frac{1}{(T-32)}$.
But work at 140 deg. Fah. = 0·386 per cent. = 158 kW.
Therefore work at 120 deg. Fah. = $158 \times \frac{(140-32)}{(120-32)} = 194$ kW.
Increase in work at 120 deg. Fah. over 140 deg. Fah. = 36 kW.
With station efficiency of 22 per cent. heat consumption = 15,500 B.Th.U./kW.
With coal at 11,500 B.Th.U./lb. coal consumption = 1·35 lb./kW hour.
Increase in coal = $\frac{1 \cdot 35 \times 36}{2240} \times 8750 = 190$ ton/annum.
Value of increased coal consumption at 15s. per ton = $190 \times \frac{15}{20}$ = £142 per annum.
In addition to the above, the loss in the main generator, house generator and oil pump at 140 deg. Fah. is 0·419 per cent., or 171·9 kW.
Hence, saving in these losses due to operating at 140 deg. Fah. instead of 120 deg. Fah. is equal to $\frac{171 \cdot 9}{158} \times$ £142 = £154.
Hence total annual saving = 142 + 154 = £296 per annum.
These losses and savings depend on the running time only, and are practically independent of the load on the generators.
Hence for a station containing five sets, of which four are always running, the total saving is £1184 per annum, and this capitalised over seven years is equivalent to £8288.

Michell pad. Not only was the brass more liable to alter its shape as the load came on, but the shape of the cross section of the oil film changed with every change in the load, in the speed or in the viscosity of the oil. Side leakage was also very important. The author had given an interesting description of some experiments with air as a lubricant. It might, however, be pointed out that there was a fundamental difference between oil and air. The viscosity of oil diminished as the temperature rose, whilst that of air increased. Hence a centrally pivoted Michell pad would work reasonably well, but would fail if lubricated with air. That fact was proved experimentally by Mr. W. Stone at Melbourne. With the pivot a proper distance behind the pad centre, air was quite a good lubricant.

Professor G. G. Stoney said that he could confirm all that Mr. Guy had stated regarding the P V rule. In turbine practice he found that about 170ft. per second and about 130 lb. per square inch represented modern usage. He could remember the day when 80ft. and 80 lb. were considered excessive. He was of the opinion that actually there was no limit, and that high speeds and high pressures went together. Concerning the difference in diameters between the bearing and the journal, he thought that an allowance of 2 mils per inch of diameter was satisfactory for large bearings, but was insufficient for small bearings. For example, the difference in the case of a 4in. bearing should, he held, be 12 mils. He would suggest the rule $1000\,\delta = 7\sqrt{d}$ for small bearings and $1000\,\delta = 2\,d$ for large. He thought that 60 deg. was quite the limit for bedding a bearing to its journal, and believed that 45 deg. would be preferable. Mr. Guy's remarks concerning the hogging effect produced in bearings by the temperature and stress conditions were very interesting, and his method of scraping away the middle portion of the bearing to compensate the effect was most original. He criticised the author's Fig. 2 as a representation of a Michell bearing. The pivoting points of the pads were a long way from the surface of the pads, and if the coefficient of friction rose there would be a danger of the pads jambing. He thought it was desirable to keep the pivots as near the surface as possible. Turbine manufacturers seemed to distrust Michell bearings on the ground that their damping effect was low, and therefore because the bearings did not eliminate vibrations as quickly as did plain bearings.

Mr. Charles Day discussed the lubrication of the bearings of internal combustion engines. The author, he said, had pointed out that white metals were used as a preventative against injury in the event of an oil film being absent on the rubbing surfaces. That feature had a special application to all types of internal combustion engines which were started by means of compressed air. A careful driver after stopping an engine, say, at the week-end, would immediately bar it round to the starting position, so as to be ready for beginning promptly on Monday morning, forgetting that during the stoppage oil would drain away from the bearings and that metallic contact might ensue. Oil might be supplied by pump or other means to the bearings before the engine was started up, but it did not separate the surfaces. As a result, the first movement at the journals might take place with metallic contact, and with considerable pressure on the surfaces. That objection could be overcome by barring round a few revolutions after oil had been supplied to all the bearings, and such a course was always advised. Dealing with the author's remarks concerning the force required to start a heavy rotor without an oil film between the surfaces, he recalled an instance which confirmed the author's experience. A large fly-wheel used with the "Ilgner" system of stored energy was provided with pumps arranged to deliver oil under the bearings at very high pressure, so as to lift the shaft from metallic contact before the fly-wheel was started. When lifted in this way a light pressure with the hand on the circumference of the fly-wheel easily moved the wheel, but he found that all the force that he could exert on the rim of the wheel did not produce the slightest movement before the shaft was lifted by the oil pressure. That experience illustrated the great difference between the friction with and without a definite oil film between the surfaces.

With internal combustion engines of the "Trunk" type, Mr. Day continued, the part most likely to suffer was the gudgeon pin, because the oil drained away more completely from the hot parts and because of the high working temperature. For those reasons the character of the metals used became important. Good bronze bearings combined with hardened steel gudgeon pins had been found the most satisfactory, but experience had shown that the hardened surfaces of such pins must be very hard and be without a single soft spot, for such a soft place, however, small, would start roughening under the conditions described, and from that roughening further injury would develop. The new "nitralloy" process of steel treatment seemed likely to meet the hardness requirement much better than case-hardening, giving as it did a harder surface and greater uniformity. Another important factor was that the hardness was retained to a much higher temperature with nitralloy treatment than with case-hardening. Reference was made in the paper to lubricating oil becoming acid. That condition, Mr. Day said, was sometimes dealt with by adding a small quantity of soda to filtered oil before returning it to the engine.

Mr. S. A. Couling, speaking on behalf of Mr. Samuelson, of Rugby, said that the British Thomson-Houston Company had carried out extensive experiments some fifteen years ago on journal bearings. The results obtained had sufficed until about three years ago, when with higher journal speeds and pressures more knowledge was necessary, and new experimental bearing tests were taken in hand. The author had pointed out that the amount of oil necessary to lubricate a bearing was very much less than that usually supplied. With that thought in view, and as a result of experiments, the B.T.H. Company had designed a bearing in which the cooling oil and the lubricating oil took separate paths through the bearing. The company's experiments had also been the means of indicating the order of bearing losses and their relation to load and speed. They confirmed the author's contention that the P V rule did not convey much of value to the designer. It was also his company's experience that bearings of exactly the same diameter and length, and loaded similarly, could have losses differing by as much as 50 per cent., the difference in the losses depending entirely on the method of cooling and lubricating the bearing.

In Fig. 1, A, B, and C showed different methods of lubricating and cooling employed in the company's test bearings. The oil inlet temperatures were kept constant at 100 deg. Fah. in all three cases. It was found that the bearing B had the extremes of temperature, the bottom half bearing being the hottest and the top half bearing the coolest, the difference being 68 deg. Fah. Bearing C, in which the cooling and lubricating oil were united, had the top and bottom temperatures very close together, differing only by 2½ deg. Fah. The temperature difference was not, however, the only consideration the designer was confronted with. It was found that the two temperatures recorded for bearing C had only been brought together, and the bottom temperature made low at an expense of power, the losses being 34 per cent. more in the case of C than for B. In addition, the oil ways influenced the state of the oil as it left the bearing. If the shaft were allowed to come in contact with the oil, and if an excessive clearance were employed, a churning action of the oil took place. The churning action was evidenced in the oil return pipes by frothing and its attendant troubles. The bearing C showed up in that respect very much worse than either of the others. The oil as it left bearing B, as might be expected, was entirely free from oil froth, since no cooling oil came in contact with the shaft, and only sufficient cooled lubricating oil to maintain the oil film was used. The temperatures of the bottom half, however, became excessive, and at speeds higher than 3000 r.p.m. the temperature became prohibitive.

The bearing B had the lowest losses as measured by the input to the motor. That fact could be explained by the circumstances that the shaft did no work in shearing the cooling oil, and, secondly, by the circumstance that the bottom temperature being high, the viscosity of the oil was reduced, and therefore the friction losses were correspondingly low. It was evident that the limit to the use of a bearing of the form shown at B was the temperature rise permissible on the bottom half. In the case of bearing A, which was supplied with lubricating oil only, the losses as measured by the oil agreed practically with the motor input, after subtracting from the latter the electrical and mechanical losses other than those of the test bearing. For bearings B and C the oil losses were higher than might be expected from the input to the motor, allowing for electrical losses, &c., but that fact might possibly be partly explained by the circumstance that much higher pressures were necessary to force the oil through the oil-ways of each of these bearings than for bearing A. Great care had to be exercised in recording the oil quantities and temperature differences, since the comparatively small error of 1 deg. corresponded to ·47 B.H.P. at 40 lb. of oil per minute. It was found

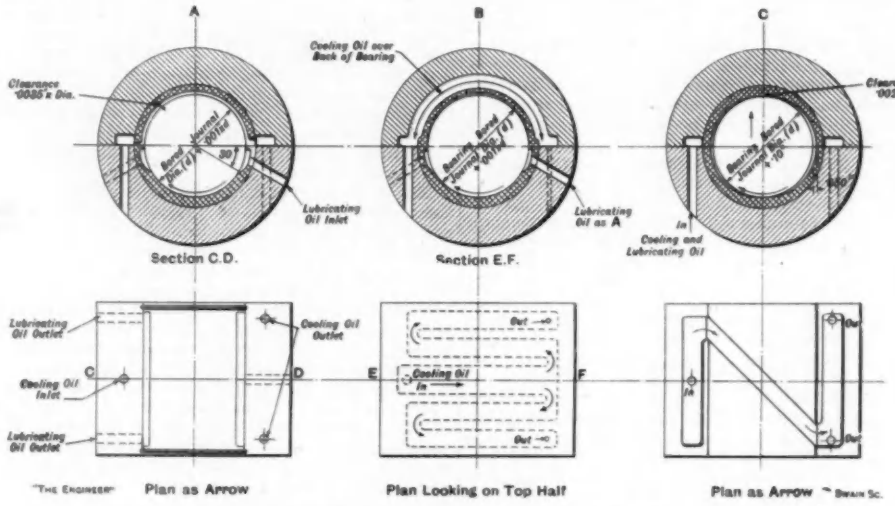


FIG. 1—B.T.H. METHODS OF LUBRICATING AND COOLING TEST BEARINGS

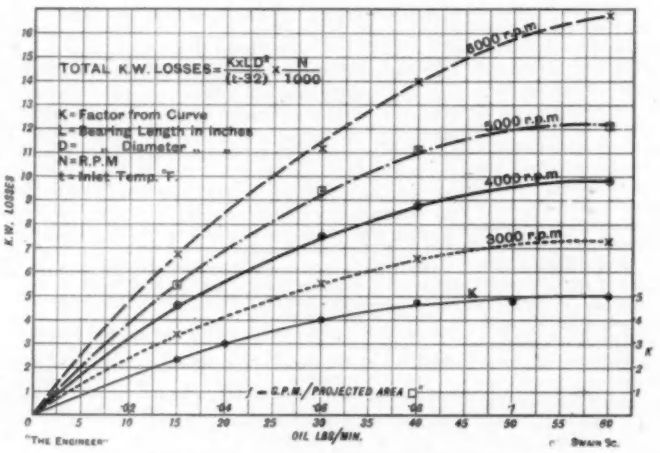


FIG. 2—LOSSES WITH VARIOUS QUANTITIES OF OIL

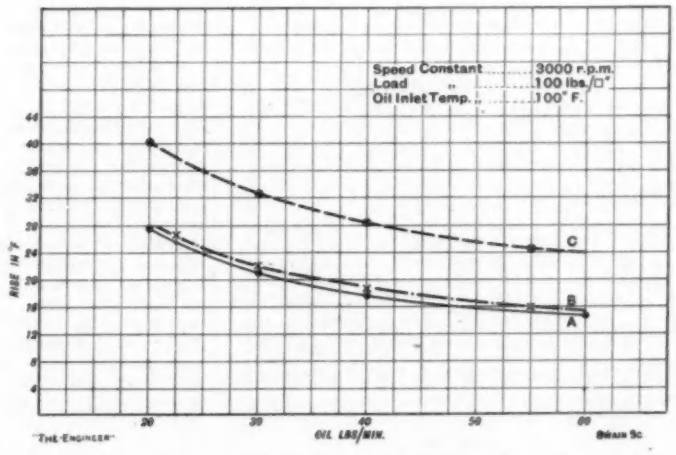


FIG. 3—OIL TEMPERATURES WITH VARIOUS QUANTITIES OF OIL

that when the bottom half temperature was allowed to rise above 200 deg. Fah. there was danger of the white metal wiping. The bearing A had been tested out very exhaustively. Fig. 2 showed the results of some tests and the relationship between losses and speed with various quantities of oil.

The author had not shown the method of introducing the oil in Fig. 1, nor did he state in which direction the oil passed through the bearing. The B.T.H. Company had found by experiment that the method of introducing the oil and also the direction of rotation of the shaft relatively to the direction of oil flow was very important. With regard to bearing clearance, it was his company's experience that if the frothing were to be kept reasonably low, and if the losses were not to be excessive, a clearance represented by ·0035 × diameter gave a reasonable figure. Fig. 3 showed the rise in temperature for the oil with the bearings A, B, and C, and for various quantities of oil. The tests had been valuable in indicating that it was wasteful to circulate more than some economic quantity of oil. A quantity exceeding the limit did not lower the bearing temperature correspondingly, and if the shaft came in contact with the oil, abnormal oil pressure could be set up on the top half, the losses being thereby considerably increased.

Mr. J. Hamilton Gibson said that the paper was a thoroughly practical one, in that it contained a maximum of practice coupled with a minimum of theory. It was all the more welcome on that account. There had been far too much theorising about bearings recently. It had been forgotten that Osborne Reynolds and others did all that was necessary in that direction years ago. Meanwhile, those who had put those theories and their conclusions into practice had reached the stage when it could be confidently asserted that any bearing, whether journal or thrust, that showed the slightest wear in service, however long that service might be, was inherently wrong, either in design or construction, or both; provided, of course, that there was an uninterrupted supply of clean and suitable oil. That that statement was no exaggeration was proved by the fact that forced lubricated bearings, and bearings of the Michell or Kingsbury type, had been known to run for years without renewal of bearing surfaces.

He thought he could claim to have fitted the first Michell journal bearings in this country some ten years ago; and when he had last heard of them they were still running with the original surfaces untouched. Those bearings were 9in. in diameter by 3½in. long, running at 1800 r.p.m., and loaded to 550 lb. per square inch of projected area. They carried the spindles of the low-pressure turbine in a British destroyer of 40,000 S.H.P., and were exposed to all the exigencies of stopping, starting, and going astern. Many other instances might be cited, but that one would suffice. The bearings referred to were described and illustrated in THE ENGINEER for August 29th, 1919. He desired to enter a mild protest against Fig. 2 in the paper being described as a "Michell" bearing. Anything more unlike a typical Michell bearing as made in this country it would be difficult to imagine. The pads were twice too thick, and one and a-half times too long. Moreover, there should always be a pad under the bottom centre to take the weight and to facilitate starting up again after a stoppage. A two-pad scheme had been tried and abandoned long ago, mainly on account of starting and stopping troubles; whereas no trouble whatever had ever been experienced with what might be called the three-pad bearing, in which one pad took the weight of the shaft at rest. A clearance of 15 to 20 thousandths per inch of diameter was provided for by boring out the pads larger to that extent. The greater clearance was required for very high peripheral speeds. The frictional losses varied as speed$^{1.5}$, and might go up to (speed)^2 for abnormally high speeds. He thanked the author for the apt definition of a good lubricant as "that fluid which possessed the greatest degree of adhesion and the least degree of cohesion"; but he could not agree that the analogy of oil particles to little rollers was fallacious. A particle might span the space between the fixed and moving surfaces in a bearing, and in adhering to both surfaces was sheared as described. We did not know the size of an oil molecule; but he imagined it would take ten or a dozen molecules to span the thickness of an oil film in a bearing, and he saw no reason to doubt that between the adhering molecules at the top and bottom of the film, the intervening molecules might behave like small steel rollers or balls. It was rather significant that the characteristic friction curves of a ball or roller bearing and a fully lubricated Michell bearing were almost identical. Concluding, he desired to repeat what he had said at the outset, namely, that in these days no bearing should wear. The metallic surfaces should never be allowed to rub. It was all a matter of getting an adequate oil supply to the right place and maintaining it there.

Mr. A. B. Smith, as the representative of an oil company, said that the author's definition of a good lubricant was broadly acceptable if the lubrication were of the intermittent type, or if it were of the boundary type. He could not accept it, however, if the lubrication were of the flood type. In such cases it was most important that the oil should retain its characteristics over a prolonged period of use. The quality of adhesion, he pointed out, might have the effect of retarding rather than assisting the removal of heat.

Mr. J. E. Southcombe, speaking as a physical chemist, said that he was particularly interested in film formation at low speeds. He agreed with Mr. Gibson that there should be no wear in bearings when in use, but the conditions which arose at starting and stopping always would cause wear. It was important to emphasise the author's statement that bearings at the start of motion must always make part of a revolution unoiled. Oils possessing the property known as "oiliness" improved the starting and stopping conditions. The author had stated that the breakdown of the film-forming phenomenon occurred at a speed of 60ft. per minute. In some experiments which he had carried out the breakdown had not occurred until a speed of 4ft. per minute was reached.

Mr. Hodgkinson briefly replied to the discussion. He expressed agreement with most of the speakers, but in connection with Mr. Day's remarks, he said that the lubrication of internal combustion engines presented a separate problem, for the loads in existence were not comparable with those encountered in turbine practice. Mr. Day intimated, in response to this observation, that the loads were really quite as high as in a turbine. Continuing, Mr. Hodgkinson said that he did not understand how the gudgeon pin of an internal combustion engine received correct lubrication, in view of the small angular motion which was involved. He agreed with Mr. Gibson that bearings should not wear, and added that if they were properly designed they did not do so. Referring to Mr. Guy's remarks, he agreed that the higher the surface speed, the easier became the lubrication of a bearing. If the means of carrying away the heat was sufficient, then the higher the pressure the better would be the behaviour of the bearings.

The World Engineering Congress in Japan.

(By Our Special Representative.)

No. I.

TOKIO, October 31st.

THE greatest of the many conferences held in Japan in recent years is now well under weigh, and daily reports appear in the newspapers of the papers read and the comments thereon, the activities of the delegates claiming a larger share of attention from the newspaper reporter than ever before in the history of such gatherings. The lively interest of the Japanese public in the proceedings of the World Engineering Congress is no less notable than the number of Japanese delegates to the Congress, or the papers the leading engineering and scientific authorities have contributed to the great mass of information recording the latest developments in the manufacturing arts and the modern science of industry.

The opening ceremony of the World Engineering Congress was in itself an achievement both in regard to its setting and the efficient way in which it was executed. Night and day men worked to complete the Tokio Municipal Hall—see page 546—the gift of a rich banker Yasuda, which contains the largest auditorium in the city, and is centrally situated. As the three thousand odd members, many with their wives, streamed into the great hall on the opening day it was realised that no other place in the city would have accommodated with comfort so great a number of people. There are larger places of public assembly, but none so well adapted for the purpose, great public meetings in the past having invariably been held in the open air.

Reports vary as to the numbers of those present at the inauguration of the World Engineering Congress. The Japanese delegates number well over two thousand, and in addition were engineers and others not delegates; the representatives of twenty-six nations numbered almost seven hundred, this figure including a large number of ladies, one of whom, Mrs. Lillian M. Gilbreth, of Montclair, New Jersey, was the only lady delegate.

Contrary to the usual practice, the hall was devoid of decoration of any sort, with the single exception of a beautiful dwarf tree some 2ft. high, placed on the speaker's table. Otherwise the place was as the builder had finished it, and all agreed that it was a worthy setting for so important an occasion. No flags or other emblems of nationality were in evidence.

The body of the great hall was filled when the Ministers of State and members of the Corps Diplomatique took their places on the platform, together with the President and officials of the Congress and the spokesmen of the delegates. The Premier sat at the head of his Cabinet, and Sir John Tilley at the head of the Diplomatic Corps, which included Mr. Troianovsky (U.S.S.R.), Baron Aloisi (Italy), and Dr. Voretzsch (Germany), Ministers of the lesser nations and the Charges d'Affaires of other embassies and legations. The spokesmen of the delegates were seated in the alphabetical order in which they spoke, as follows:—American, Elmer A. Sperry; British, E. F. C. Trench; Chinese, Hu Wei; French, Bes de Bere; German, Carl Koettgen; Italian, Luigi Luiggi; Swedish, Axel F. Enstrom.

The Imperial Patron and Honorary President, Prince Yasuhito, of Chichibu, popularly known as Prince Chichibu, entered and ascended the platform, when the martial notes of the Kimigayo filled the hall. His Imperial Highness was in morning dress, and read easily and in a clear voice in the language of his country, the opening address, an official translation of which runs as follows:—

> It is a very real pleasure, to meet here such a large gathering of distinguished specialists, many of whom have come from far-off countries, and to speak a few words to them on this occasion of the opening of the World Engineering Congress.
>
> It is a trite observation that the development in our time of so many and various industries has materially enhanced the importance of the bearing which engineering exercises on the economic life of the population, nor need I emphasise the fact that the progress of engineering is constantly making ever-increasing contributions to the development of those industries. But it is also evident that the promotion of further research, and the continuous acceleration of advance, both in the theory of engineering science and in the practice of industrial technique, presupposes a candid and constant co-operation on the part of the world's scientists and captains of industry. Moreover, we see in all countries that these questions of industrial economy constitute the keystone of every problem, national and international alike, and that there are not wanting signs of a growing spirit of economic emulation among the nations. It is obviously most important, therefore, that all the countries of the globe should maintain in their industrial activities a harmonious concord and co-operation, each paying due regard to the principle of a fair participation by all in international industry and international commerce.
>
> In the light of these considerations, I am convinced that the benefits to be derived from the work of this Congress will not be confined to the field of the world's engineering and industry alone.
>
> In conclusion, I desire to express my appreciation of the enthusiastic support afforded by the participating countries and of the trouble which many of you have taken in traversing distant seas. It is my earnest hope that this Congress, by virtue of your co-operation, will succeed in making a worthy contribution towards the furtherance of the welfare of mankind.

Applause greeted the Prince when he had finished, the hearty response coming from the foreign delegates, and, thus encouraged, the Japanese delegates followed suit in a demonstration not customary on such august occasions.

The Imperial address was duly interpreted, as were those of the Premier, delivered in a strong sonorous voice well befitting the "Lion," his Excellency's newspaper sobriquet, and the aged President of the Congress, Baron Furuichi.

While Japanese was the language of the first three speakers, that *lingua franca* of the East, the English tongue, was for the first time in Japanese history on such a distinguished occasion the common language of the speakers who followed—the delegates' representatives. All spoke in English. On no like previous occasion had a French delegate, for example, spoken in a foreign language, and the Chinese was almost equally an exception, for both are rightfully proud of their native tongues. There was, however, one brief exception to the rule.

Mr. Sperry, a distinguished American well known in Japan, interested his audience in his story of the origin and development of the idea of holding the World Congress in Tokio, which had its origin in the suggestion of the American Society of Mechanical Engineers. Mr. Sperry referred to President Hoover's keen personal interest in the Congress, and of the visits of the American delegates to the graves of two Americans closely associated with the dramatic days when Japan was being opened to the world, those of Commodore Perry and Townsend Harris, the first United States Consul in Japan. Framed photographs of their graves will adorn the rooms of the Koggakai, the principal Japanese engineering society, and be a constant reminder of the close association with this country of the two Americans who played so prominent a part in the early days immediately preceding the opening of Japanese ports to foreign trade.

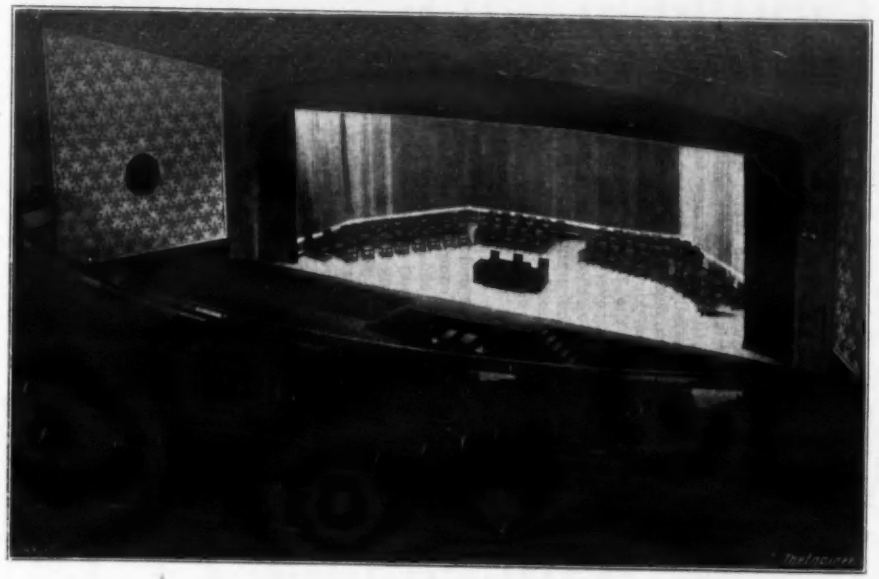
Clarity of utterance is the first essential of English speaking in the East and will succeed where eloquence will fail to inspire or convey the message a speaker wishes to reach his audience. The great majority of any such international audience will read the English language with ease, a smaller proportion will be able to write with ease, but not 10 per cent. of any audience understands he spoken word. Many, therefore, were thankful to the English spokesman, fortunate in the possession of a clear and distinct enunciation, and what he said was equally clear, brief and to the point. He spoke on behalf of the engineers of the British Empire, to a people many of whose engineers had their early training in Great Britain. Mr. Trench's words were heard throughout the great hall.

It was a mistake on the part of all the remaining delegates that they did not speak in their own language—all would have preferred the inimitable Mandarin to the English that was read, and the beautiful French tongue.

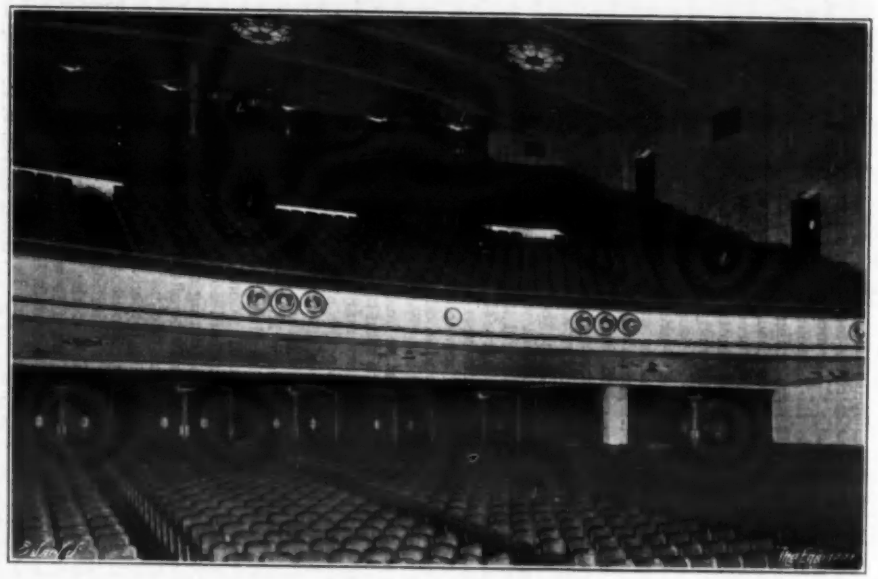
The honours of the day must be accorded to the Italian representative, Signor Luiggi, who towards the end of his address in English, begged to be allowed

THE JAPANESE ENGINEERING CONGRESS—TOKIO MUNICIPAL HALL

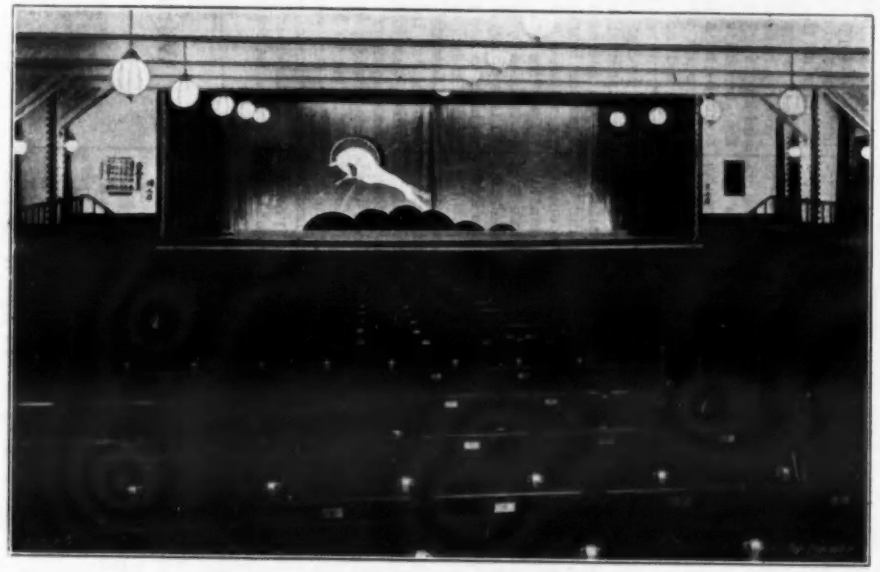
FRONT AND SIDE ELEVATION



STAGE OF THE HIBIYA AUDITORIUM



HIBIYA AUDITORIUM



LECTURE HALL IN BASEMENT

to use the language of Dante, Marconi, and Mussolini, and proceeded to address the Prince directly, in a manner and tone that pleased the whole vast audience. Not one per cent. of the audience understood, but all were charmed, and all understood the startling *dénouement*, when the admirer of Mussolini shot up his arm like a signal and shouted "Banzai!" It was the first departure from solemn precedent in that decorous gathering. For a moment everybody was transfixed, the Prince especially; but he quickly recovered, smiled, and everyone broke forth in laughter and applause. New Italy had spoken, and friends subsequently spoke of the revolutionary Luiggi.

The formal part of the opening ceremony was concluded by the presentation to Baron Furuichi of greetings from the principal countries, which took various forms. The Czechoslovakian representative read greetings from Prague; the British representatives presented several scrolls: Mr. R. W. Allen, scrolls on behalf of London and Cambridge Universities and the Institution of Mechanical Engineers; Mr. Foster J. King, scroll from the Society of Naval Architects; Professor Hillhouse, scroll from the Society of Engineers and Shipbuilders of Scotland; and Mr. Trench, a scroll from the Institution of Civil Engineers. There were American and other national greetings, and on the conclusion of the presentations the Prince rose and departed to the strains of the National Anthem.

The formal opening of the World Power Conference in the Lower House of the Imperial Diet took place in the afternoon, and was in all respects similar to that of the morning.

Practically one full week is devoted to the work of the conference, but from this time must be deducted the hours devoted to luncheons, garden parties and evening entertainments, so that there is all too little opportunity for concentration and debate.

The chief centre of the activities of both Conferences is the Diet building, a temporary structure superseding the building which was destroyed by fire in 1925. Here are all the committee rooms, the distribution and excursion offices, post and telegraph offices, &c., and as between four and five thousand people are making continuous use of the building, which consists of only two floors, the daily scene is one of unceasing activity. There is a great demand for the publications of both conferences from Japanese students, who are conspicuous by their uniforms and distinctive caps. The papers of members will have many appreciative readers among the younger generation.

Sectional meetings are held from 9.30 in the morning to midday, and from two to five. At the end of each day brief reports of meetings and discussions are furnished to the newspapers. Synopses of the papers were available on the first day of the conference, from which could be gathered the range of the subjects discussed. Many of these are not directly related to engineering, notably some interesting contributions on business management and labour saving; at the other extreme are papers on pure engineering topics, highly technical, and, when the author is Japanese, not made easier by the difficulties of the English language. In such instances, what may appear difficult in the manuscript is readily elucidated in the committee room by means of the blackboard and lantern slide.

(To be continued.)

An Empire Economic Union.

THE following manifesto has just been received. It is of particular interest to us, in view of the leading article in our issue of November 15th, entitled "Economics and the Empire."

We, the undersigned representatives of British industry, having carefully studied the economic and industrial position of world trade, have come to the conclusion that it is imperative to establish between all parts of the British Empire a policy of closer and more intimate mutual economic co-operation than exists to-day. Such a policy is necessary in order to secure the full and rapid development of the agricultural, mineral and manufacturing resources of the other nations and communities of the British Empire, as well as to maintain and develop the agriculture and the industry, employment and standard of living of the people of the United Kingdom.

We believe that the scope for such a policy and the full meaning of it are but little understood. It is not merely that of a total annual import into all Empire countries of £2,200,000,000 only some £900,000,000 come from the Empire, leaving an enormous margin, most of which could be supplied from Empire sources. It is even more the almost incalculable stimulation to productive power and enterprise in every part of the Empire which would result from the conservation and circulation within the Empire of the creative energy represented by our purchases.

The need for a prompt and bold decision is being forced upon us. It is not only that our own trade and employment position in Great Britain calls for immediate action. For every member of the British Commonwealth the course of developments outside is confronting us with alternatives between which we shall be compelled to choose. The United States of America, following a policy of mutual economic co-operation over a vast and rich territory, have built up a position as the dominating power in the economic world. In Europe far-seeing men realise that the day of small economic units is passing away, and our former allies and enemies are being rapidly forced to consider some form of closer economic union for a continent. In the coming re-alignment of world economic forces can the nations of the Empire afford to remain isolated economic units? Will they not be compelled, unless they are to fall behind in the whole progress of world development, either to accept absorption in one of the great neighbouring groups—Great Britain in the European group, the Dominions in the American economic orbit—or else to combine to make the Empire an economic unit? Comparing the resources and potentialities of the Empire group with those of Europe or the United States, apart from all considerations of the political consequences of our choice, we stand unhesitatingly for the Imperial solution.

We cannot admit that the problem of the economic unit of the British Empire, so largely peopled and governed by men of common origin, common speech, and a common political tradition, naturally dependent on each other for food, raw materials and manufactured goods, is one incapable of solution. The task of finding ways and means for promoting the greater interchange of our products and increasing the demand for the employment of all our peoples, is surely within the capacity of men of knowledge, ability and good will meeting in conference together.

We fully realise that there are many obstacles of detail to be overcome. We know that we have to deal with conditions as they have developed, and that the hands of the clock cannot be set back, so as to recreate the simpler conditions on which the United States built up their economic system. But if the ideal of an absolutely free interchange of all Empire products within the Empire is not realisable, at least under the conditions of our day, let us at any rate get as near to it as we can. Let us by consultation and discussion, by mutual give and take, modify whatever is vexatious and hampering in our various fiscal and trading systems, without being essential to our individual economic policies, and ensure that inter-Imperial trade, if not absolutely unchecked, shall at any rate flow as freely and in as full volume as statesmanship and the good will of our peoples can enable it to flow.

For this purpose the representatives of this country must have a free hand. The objective is so vital to the future of our own people and of the whole Empire that no method of achieving it can be ruled out. All possible avenues towards its fulfilment must remain open for investigation and consideration, for negotiation and mutual arrangement. We are not concerned, at this stage, with advocating the imposition of preferential tariffs to the exclusion of other lines of approach, such as schemes of mutual purchase, freight reductions, inter-Imperial mergers and rationalisation arrangements, or the promotion of scientific research and the stimulation of voluntary preference. All we ask is that no method should be ruled out by theoretical objections or by loosely worded pledges excluding whole unclassified categories from consideration. We appeal to the political world for an amnesty with regard to past controversies and declarations, and for a truce which will enable our representatives at the forthcoming Imperial Economic Conference to do their best, in unfettered freedom, for our people and for the Empire.

To the industrial world we would make a similar appeal. We would remind them that the Interim Joint Report on Unemployment adopted by the full joint meeting on March 12th, 1929, of the Melchett-Turner Conference on Industrial Reorganisation and Industrial Relations, contained the following passage:—

> "If the British Commonwealth could be brought together as an economic unit, it is felt that the problems both of emigration and of unemployment could be regarded in an entirely new aspect."

We might add that it was with an even more explicit insistence upon the importance of the economic unity of the Empire that Mr. Ben Tillett recently opened his presidential address to the annual congress of the Trade Union Council.

For our own part we are anxious to make such contributions as we can to a fuller study of the practical, detailed aspects of the problem, to the spread of information, and to the creation of a general interest in the policy of Empire economic unity and the development of Empire resources. In this task we would welcome the co-operation of all who are interested in the question, more particularly of business men in every rank of industry.

We have formed a provisional organisation, the Empire Economic Union, to study the problem and to advocate the policy, both here and throughout the Empire, in co-operation with other leaders of industry. All communications should be addressed to the Secretary, Mr. Herbert G. Williams, 351, Abbey House, Victoria-street, S.W. 1.

Rt. Hon. LORD MELCHETT, P.C., D.Sc., F.R.S., Chairman, Imperial Chemical Industries, Ltd., &c.
Rt. Hon. LORD WARING, Chairman, Waring and Gillows.
Rt. Hon. LORD WEIR, P.C., Chairman, G. and J. Weir.
SIR HARRY BRITTAIN, K.B.E., C.M.G., Director, D. Napier and Son, Ltd.
SIR ABE BAILEY, Bt., K.C.M.G., Director of South African Companies.
SIR HERBERT AUSTIN, K.B.E., Chairman, Austin Motor Company, Ltd.
SIR ROBERT HADFIELD, Bt., F.R.S., D.Sc., Chairman, Hadfields, Ltd.
SIR HUGO HIRST, Bt., Chairman, General Electric Company, Ltd.
SIR HARRY MCGOWAN, K.B.E., President, Imperial Chemical Industries, Ltd.
SIR BENJAMIN H. MORGAN, Chairman, Sugar Federation.
SIR GEORGE A. TOUCHE, Bt., Partner, George A. Touche and Co.
SIR WILLIAM LARKE, K.B.E., Director, National Federation of Iron and Steel Manufacturers.
SIR HUGO CUNLIFFE-OWEN, Bt., Chairman, British-American Tobacco Company.
SIR JOHN FERGUSON, K.B.E., Chairman, Liptons, Ltd.
Hon. HENRY MOND, Director, Imperial Chemical Industries, Ltd.
V. A. MALCOLMSON, Partner, Scrimgeour and Co.
ANDREW HOLT, Director, Andrew Holt and Co.
SIR H. R. CAYSER, Bt., Vice-Chairman, Cayser, Irvine and Co., Ltd.
R. W. FFENNELL, Director, Central Mining Investment Corporation.
Dr. A. E. HUMPHRIES, Chairman, Flour Milling Employers' Federation.
Mr. R. D. BLUMENFELD, Chairman and Managing Director, London Express, Ltd.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ENGLISH CANAL TRANSPORT.

SIR,—It is unfortunate that the presidential address to the Institution of Civil Engineers should have savoured of railway propaganda directed against the improvement of our inland waterways, though it is fair to state that the President tendered his views "as a railway engineer," and transportation specialists will appraise them accordingly.

The decline of English canal traffic is solely due to the antiquated state of the great Midland Junction Canal network centred on Birmingham and owned by the L.M.S. Railway Company. Its gauge is a century out of date, and that city, which Americans have openly declared they would make an inland port if it belonged to them, is unapproachable from any coast port by vessels of more than 7ft. beam. This network thus dominates the entire canal system, in particular the arterial routes connecting London, Liverpool, Hull, and Gloucester, and renders improvement elsewhere mere waste of time, since no transportation system can function efficiently unless it is of modern and uniform gauge, and gives through traffic facilities to all distribution centres.

Whether the canal system should be remodelled or left to go still further to perdition depends upon one thing only—the ton-mile cost of transit over a modern gauge canal.

Despite the cry for cheaper transport, nowhere in this country to my knowledge are goods being carried by road or rail for even 1d. per ton-mile, but there is abundant evidence that even small motor barges, of 80 tons deadweight or so, can carry at ¼d. per ton-mile, all charges included. Using larger craft or trains of barges behind a motor tug the cost is considerably lower.

It is difficult to see how production can be cheapened by alterations in hours and wages. Overhead expenses we know to be practically irreducible, except as concerns inland transport, and, willy nilly, we shall have to turn to our inland waterways, remodel them, and even cut new canals.

Notwithstanding the present speed mania, we find that directly we come to the question of food we return to economic sanity and cost is the ruling factor.

The farmers are now pressing for import duties or subsidies, by which it is claimed another 2,000,000 tons of wheat can be produced at home.

To send 100,000 tons of it from, say, the Devizes area to the Bristol millers by rail or road would cost from £30,000 to £40,000 more than if it were sent in barges over a modernised Kennet and Avon Navigation. These excessive costs would, of course, be passed on to the consumer, who would pay the subsidy as well, so it is clear that without efficient canal transport the farmers' case is hopeless.

England is a well watered country and the existing waterways system serves all our industrial and many important agricultural districts.

It is tragic that the world's greatest maritime nation should have deliberately neglected one sure avenue to economic salvation, and that there is not throughout the country to-day one single unemployment relief scheme, which, while providing work, will have any effect whatever in reducing the cost of production and cost of living.

G. C. C. HENDERSON,
Captain, late Royal Engineers.

Yeovil, November 16th.

SCHNEIDER CUP SPEEDS.

SIR,—In your issue dated October 4th a correspondent raises the question as to what the effect on the air will be of the loud exhaust of an aeroplane approaching an observer at a speed equal to that of sound. Theoretically, I imagine that in perfectly still air the sound would travel with the aeroplane, and that the cumulative effect of the engine exhaust, combined with the shriek set up by air resistance to the machine, would have a devastating effect on the ear drum. In practice, however, atmospheric conditions would seldom favour maximum reception, and the observer's ears would thus be mercifully spared. The effect of the whistling noise emitted by projectiles, whose velocity is greater than that of sound, may afford some clue to the conundrum. Among soldiers there is a consoling maxim that one never hears the bullet that hits one, meaning, presumably, that when the sound reaches the ear the bullet has passed by. In practice, the whistle and the bang of high-explosive shrapnel occur at barely perceptible intervals; hence the term "whiz-bang" which was applied to it by the B.E.F. in 1914. B. J. K.

Calcutta, October 29th.

SMOKE EMISSION BY CHIMNEYS.

SIR,—"It is my aim to see that all Government offices set an example to the nation in smoke abatement, and as soon as it is a practicable proposition every office in Whitehall will be burning nothing but smokeless fuel." Thus, Mr. George Lansbury, First Commissioner of Works, recently, when attending a smoke abatement demonstration at 28, Grosvenor-place, London.

Might I suggest that Mr. Lansbury might, beneficially, turn his attention to the large chimney at the Law Courts, which constantly, during the cold months, emits vast volumes of intensely black smoke?

ASSOC. M. INST. C.E.

Public Works, Roads and Transport Exhibition.

No. I.

Introduction.

The Public Works, Roads and Transport Exhibition was opened at the Royal Agricultural Hall, Islington, on Monday last, November 18th, and will close to-morrow night. The first impression made on our minds on entering the Hall was that the Exhibition bore a very strong resemblance to those which had gone before it; in fact, that it might well be a repetition of the Show of two years ago. There were the same familiar names, and many were to be seen on the same sites which they have occupied in successive Exhibitions at two-year intervals for a long time past.

Closer examination, however, made it clear that, though much which had been shown before was again on view, there were also many novelties to be seen, and that, in addition, there had been multifarious improvements on pre-existing models, which had—though many of the latter were, to outward seeming, identical with their prototypes—practically made them into new machines.

Then, again, it was noticeable how many firms have turned their attention nowadays to the production of light rail tractors propelled by internal combustion engines. The indications are that the steam-driven contractors' locomotive is likely to have to face very severe competition from these handy little engines, many of which are exceedingly well designed and constructed, and some of which are quite powerful. A great point made by the manufacturers is that the engines only use fuel when they are actually at work, and that they can be put into service at a moment's notice; there is no waiting to get up steam. We shall, in what follows, refer to several of the locomotives of this type that were exhibited.

Another noticeable point was that more firms than ever are directing their energies to the production of road signs of various types, all of them designed with the object of facilitating traffic. The old finger-post which is so often illegible, seems doomed to disappear, its place being taken by easily-read cast iron arms carried on substantial metal standards. We saw one case in which the refinement of illumination had even been provided. Steady and flashing beacons come more into prominence each year. There were examples on quite a number of stands, while reflecting signs, which spring into sight when the beams of headlights strike them, are shown in quantities.

It would appear that there are more stands than ever which contain examples of road materials of different natures and sizes. There are, at any rate, upwards of fifty of them in the present Exhibition. Seeing that so much material entirely suitable for road construction is available at home, it is all the more difficult to understand why so much stone is still being imported from abroad. The number of manufacturers of binding materials of tarry or bituminous nature continues to multiply. There are nearly half a century of them showing at Islington at this moment.

To sum up the Exhibition as a whole, it would perhaps not be overstating the case to say that nearly half of the whole of it is taken up with road-making and surfacing materials of various kinds, including wood and rubber blocks, and that 75 per cent. of the remainder is devoted to machinery for making, repairing and maintaining roadways.

We now propose to refer to those of the exhibits which are likely to be of most interest to our readers, and we shall confine our remarks very largely to those items which are themselves entirely novel, or which embody new features which differentiate them, to a greater or less degree, from anything which has hitherto been exhibited. In doing this we shall observe no special order, and should one thing be discussed before another of a similar character shown by another maker, it must not be taken that we consider the first better than the second, or, indeed, than any other exhibit of a like kind.

Ruston and Hornsby, Ltd.

We always look for some interesting exhibits on the stand of Ruston and Hornsby, Ltd., and we have not been disappointed in the present instance. There is, as was to be expected, the large No. 4 petrol-paraffin engine driven Universal Excavator, which is carried on independently movable caterpillar tracks. We have seen it before, of course, but, whereas at the Exhibition of two years ago it was arranged to operate as a shovel with a ½ cubic yard bucket, this year it is fitted with back-acting trencher equipment. Close beside it are the necessary accessories to convert the machine into a standard shovel, and visitors are reminded that it can also be employed as (*a*) a dragline excavator for drainage work; (*b*) a grabbing crane; (*c*) a skimmer scoop for road making; and (*d*) an ordinary locomotive crane.

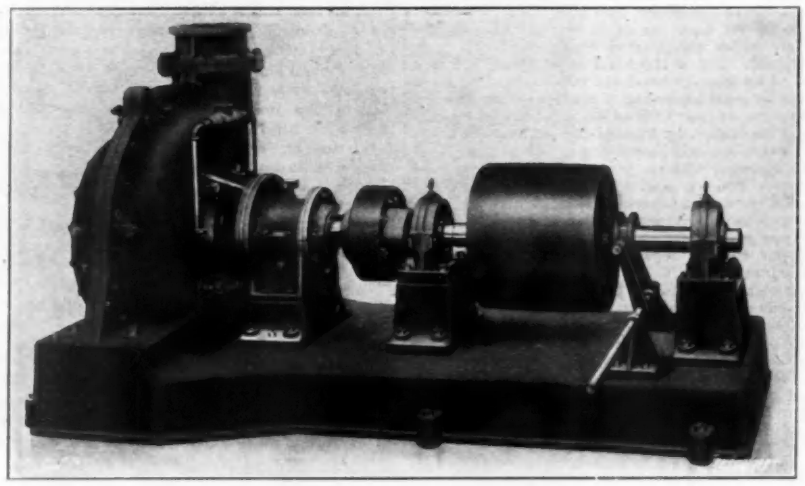


FIG. 1—8-INCH GRAVEL PUMP—RUSTON

There are three novelties on the stand—*i.e.*, a three-wheel crude oil road roller, a gravel pump, and a contractors' lift pump. The roller is illustrated in the engraving, Fig. 2. It is rated as weighing 11 tons in working order, and we gather that five other sizes of the same type of machine are being made, their weights varying from 3½ to 15 tons. The engine, which is designed to give 20 brake horse-power on fuel oil and 22 B.H.P. on refined oil, and has its cylinder placed horizontally on the frame, is totally enclosed and is of the medium compression four-stroke type. It can, so we gather, run efficiently on a wide range of fuels, including petroleum, gas oil, solar oil and good residual fuel, with a specific gravity not exceeding 0·9. It can be started from cold by using petrol at first and then turning over to oil, a special petrol starting attachment being fitted for the purpose, and there is an arrangement by which compressed air is employed to impart the initial movement to the fly-wheel. Cooling is effected by means of a hopper and the exhaust is led up a chimney that clears the awning top. Forced lubrication is applied to the main bearings and the makers claim that the amount of lubricating oil needed is very small and compares favourably with that necessary for high-speed petrol or paraffin engines.

With this sized roller, the width rolled is 6ft. 2in. The front rollers are 3ft. 6in. in diameter, and have a width of the same dimension. The hind rollers have a diameter of 5ft. 3in. and a width of 1ft. 6in. The drive is taken from the crank shaft, first by a steel roller chain, which is furnished with readily accessible adjustments for taking up wear, then by direct spur gearing to the roller rims. The engine can be used for driving machinery by belt, the travelling gears being disconnected by putting the control levers into the neutral position. There are three speeds in both directions, *i.e.*, one-half, one, and two and a-half miles per hour. Steering is effected by a hand wheel which operates a worm gear acting on a steel trunnion. The trunnion is turned to fit the fore-carriage and hinged to the steering fork, which is of steel. The makers point out that by the adoption of this design the backlash experienced with chain steering gear is eliminated.

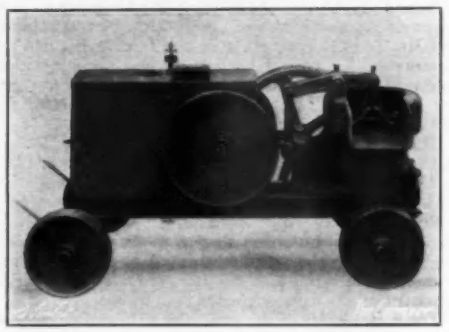


FIG. 3—CONTRACTOR'S LIFT PUMP—RUSTON

Alongside this roller is a smaller roller of the tandem type. It has a weight of 6½ tons in working order, and it, too, is driven by a fuel-oil engine.

The gravel pump is illustrated in Fig. 1. This pump has been specially designed for pumping water containing hard solids, and is claimed to provide the most economical method of "winning" gravel where water is present in the pits. Both the impeller and the liner are of cast manganese steel, those portions subject to the hardest wear being made extra thick. The pump has an 8in. suction and is said to be able to pass hard solids not exceeding 7in. in diameter sphere. The bearings are of the heavy roller type, and are grease-lubricated. The pump is arranged for belt driving, and is furnished with a friction clutch pulley which is operated by a hand lever. The pump is designed for gross heads up to 100ft., and the average output is given as being 1300 gallons per minute. At that rate, supposing the solids to form 10 per cent. of the mixture being dealt with, approximately 45 cubic yards of the solids would be raised per hour.

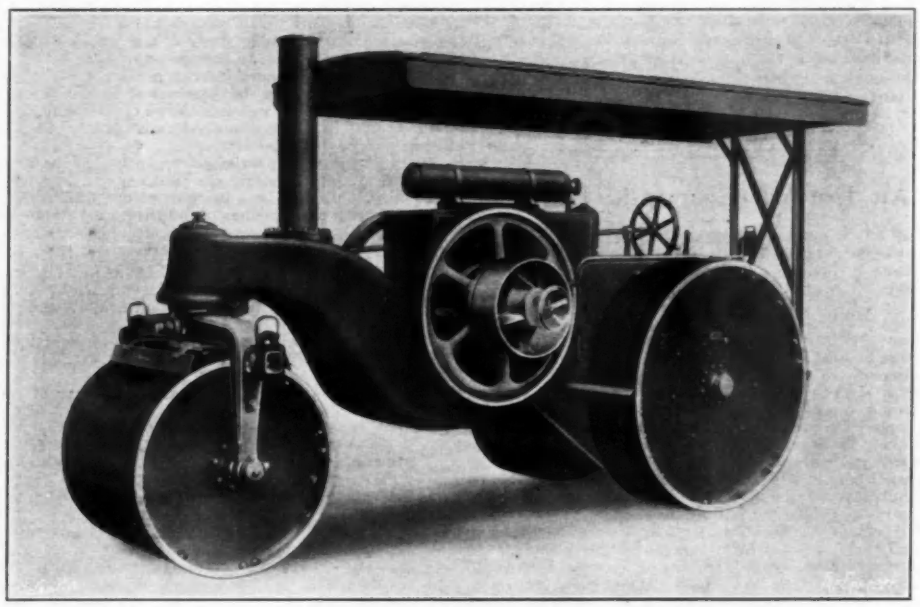


FIG. 2—11-TON THREE-WHEEL CRUDE-OIL ROAD ROLLER—RUSTON

The contractors' lift pump is illustrated in Fig. 3. It is a compact little unit, with overall dimensions, 4ft. 7½in. long by 2ft. 9in. wide and 2ft. 10½in. high. It is driven by a 2 B.H.P. totally enclosed petrol paraffin engine, and has a capacity of from 4000 to

5000 gallons per hour, the diameter of the suction pipe being 3in. Grease lubrication is employed throughout, and the machine has the appearance of being capable of withstanding well the hard usage that, as a piece of contractors' plant, it is certain to be subjected to.

F. C. Hibberd and Co., Ltd.

Three small locomotives fitted with internal combustion engines are shown by F. C. Hibberd and Co., Ltd., of 16, Northumberland-avenue, London, W.C. 2. They are of 20, 10, and 6 brake horse-power respectively. The largest of the three is the 20 B.H.P. "Planet," which is illustrated in Fig. 4. Its gauge reversing pinions, and there are two speeds in either direction, the wheels being always in mesh and engagement being obtained by dog clutches. The shafts are carried in ball bearings with a double ball thrust on each. The drive from the gear-box to the axles is by roller chain through a central countershaft, which carries the brake drum. The first drive is by duplex chain with a 1in. pitch and $\frac{5}{8}$in. rollers, and the final drive to each axle is by single chain, 1$\frac{1}{4}$in. pitch and 1in. rollers. The fly-wheel, which is a semi-steel casting, machined all over, and dynamically balanced on a rotary balancing plant, is spigoted on the crank shaft flange and secured by six steel bolts. The clutch is of the inverted cone type, the cone being a light-

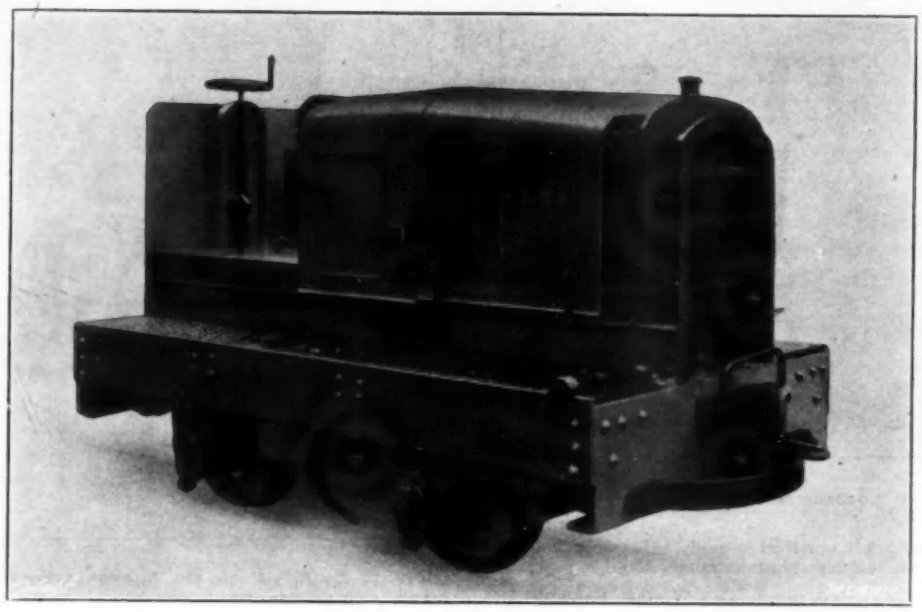


FIG. 4—20-B.H.P. "PLANET" LOCOMOTIVE—HIBBERD

is variable from 20in. to 3ft., and its wheel base is only 3ft. 6in. The overall height to the top of the brake lever is 4ft. 6in., the length over the buffers being 8ft. 9in., and the extreme width 4ft. 2in. This little engine is credited with being able to haul a gross load of 33 tons on the level at a speed of 3$\frac{1}{2}$ miles per hour, and a load of 4$\frac{3}{4}$ tons on an up gradient of 1 in 20 at the same speed. At 8 miles per hour it can, it is said, haul a load of 20$\frac{1}{2}$ tons on the level and 2$\frac{1}{4}$ tons up a gradient of 1 in 20. The speed of the engine at both speeds is 1200 r.p.m., the tractive efforts being 1062 lb. and 686 lb. respectively.

The engine has four cylinders, each 75 mm. bore weight aluminium casting, machined and balanced. It is fitted with die-shaped Ferodo fabric and is fitted with progressive engagement rings with the object of making it impossible for the clutch to "snatch" or jump if let in hastily. All the thrusts are taken on ball bearings.

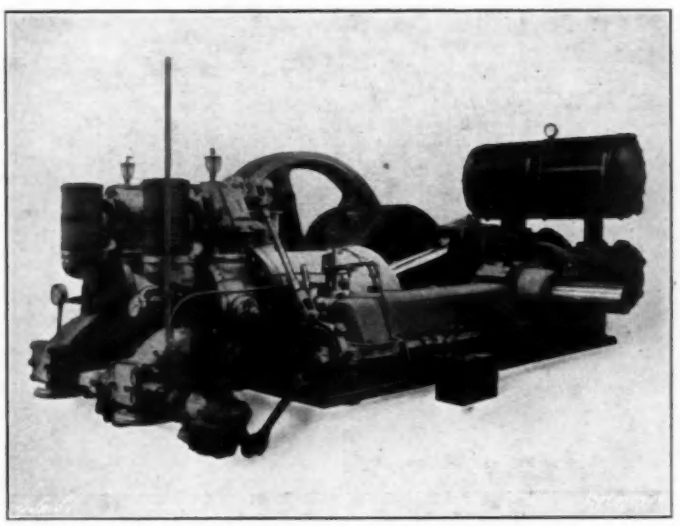
The wheels, which are of chilled cast iron, are 17$\frac{3}{4}$in. in diameter, and the springs, which are flat laminated, are of oil-hardened silico-manganese steel. Centre buffer couplings with a spring fender are fitted as standard, but other types of buffing gear can be fitted if required. The buffer height from the rails is 13in. The brakes, which are of the screw-down pattern,

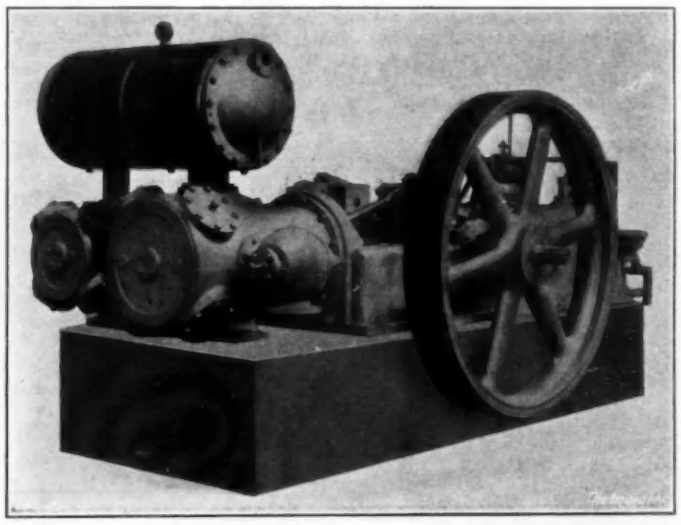
Robey and Co., Ltd.

In addition to their usual display of steam and oil engine-driven road rollers and a stone crusher, Robey and Co., Ltd., of Lincoln, were showing a novelty in the form of a horizontal two-stage air compressor driven by a crude oil engine. It is shown in Figs. 5 and 6. The two driving cylinders are arranged side by side opposing the two compressing cylinders, the caps of the crank ends of the oil engine connecting-rods being arranged to take the compressor crank pins and transmit the power through the compressor connecting-rods to the compressor pistons. The whole, as will be seen from the illustrations, forms a compact unit and it certainly appears to be a most excellent example of workmanship. The engine is of the firm's "cold-start" crude oil type, having an output of 110 horse-power at a speed of 240 revolutions per minute, and the air cylinders measure 16in. and 9$\frac{1}{2}$in. in diameter respectively, with a common stroke of 22in. The machine is designed to pass 500 cubic feet of free air per minute compressed to 100 lb. per square inch.

The crank shaft is machined from a solid forging and is extended to carry a fly-wheel at each side. It is carried in double ring oiling bearings. The connecting-rods are also machined from solid steel forgings. The air and exhaust valves are operated by levers and rods actuated from a massively constructed excentric keyed to the cam shaft. This design, as the makers point out, eliminates the knocking and jarring which may be experienced with engines fitted with cams and rollers. The regulation of the engine is effected by controlling the amount of each fuel charge. A plunger pump with a variable-stroke plunger forces the oil through the atomiser. A sliding roller, actuated by a governor, adjusts the stroke of the pump. The governor, which is of the spring-loaded type, is driven by chain from the cam shaft through spiral gear wheels which all run in oil. The thrust on the vertical shaft is taken up by ball bearings. Starting is effected by compressed air, the engine being fitted with an automatic air valve which is mechanically-operated by a cam on the side shaft. A spring-loaded safety valve is also fitted to each cylinder so that the latter may not be subjected to excessive stresses. As a further measure of safety, a special form of combined safety and relief valve is fitted in the delivery side of the fuel oil pipe line to prevent excessive pressure being set up between the fuel pump and the atomiser. For enabling thick oil to be used in cold weather a cast iron heater is arranged at the side of the exhaust pipe. The atomiser is made from solid steel and is fitted with a new form of plunger valve, for which provisional protection has been obtained, and which is claimed to ensure a perfect cut-off at all loads.

The inlet and outlet valves of the air cylinders are identical in shape and are interchangeable. They are of the "Robey" automatic disc type, which are formed with an attachment that enables guide studs or other supports to be dispensed with, and they are held in position by coiled springs of square section, the springs fitting into flanges on the outside edges of





FIGS. 5 AND 6—CRUDE-OIL ENGINE-DRIVEN COMPOUND AIR COMPRESSOR—ROBEY

by 120 mm. stroke. It has overhead valves and is water cooled. Forced lubrication is employed, there being a self-contained oil pump and a fan for inducing air circulation through the radiator. This engine has, we are told, proved itself capable of running for indefinite periods at as high a rate as 3000 r.p.m., but, in the locomotive, the rated speeds are, as has been said, obtained with an engine speed of 1200 r.p.m., at which speed 20 B.H.P. are developed on petrol. It can be safely run continuously at a speed of 2300 r.p.m., at which the corresponding travelling speed in top gear is 10 miles per hour.

The gear-box is of the two-shaft pattern, with bevel operated by hand wheel from the driver's cab, act on all four wheels. The weight of this handly little engine in running order is given as being 2$\frac{1}{4}$ tons. The capacity of the petrol tank is 8 gallons. The makers state that one gallon will give, approximately, 80 ton-miles, while the average fuel and oil consumptions for an eight-hour day are 3 gallons of petrol and 1 pint of oil. It is pointed out that the 20 H.P. "Planet" is, essentially, a petrol locomotive, but that, in certain climates, paraffin can be used satisfactorily for running after starting up on petrol. In this case, however, a vaporiser and two fuel tanks have to be fitted.

the valves, and being held at the other end by the guard plate. There is an intercooler, with a tube surface of 125 square feet between the first and second stage air cylinders, which is furnished with a pressure gauge and a safety valve. An air governor controls the amount of air compressed to suit the demand while the compressor is run at constant speed. It takes the form of a valve fitted to the intake of the compressor, which shuts off the inlet to the compressor according to requirements. This valve is operated by the air pressure in the receiver, closing as the pressure rises and opening as the pressure falls. The amount of air may also be controlled by altering the speed of the

engine, which may be effected while the latter is running.

JOHN FOWLER AND CO. (LEEDS), LTD.

As usual, John Fowler and Co. have a striking display, but what they are showing are, for the most part, old friends. For instance, there is their complete road-making plant, a 10-ton three-wheel Diesel road roller, some concrete mixers, and a steam gully

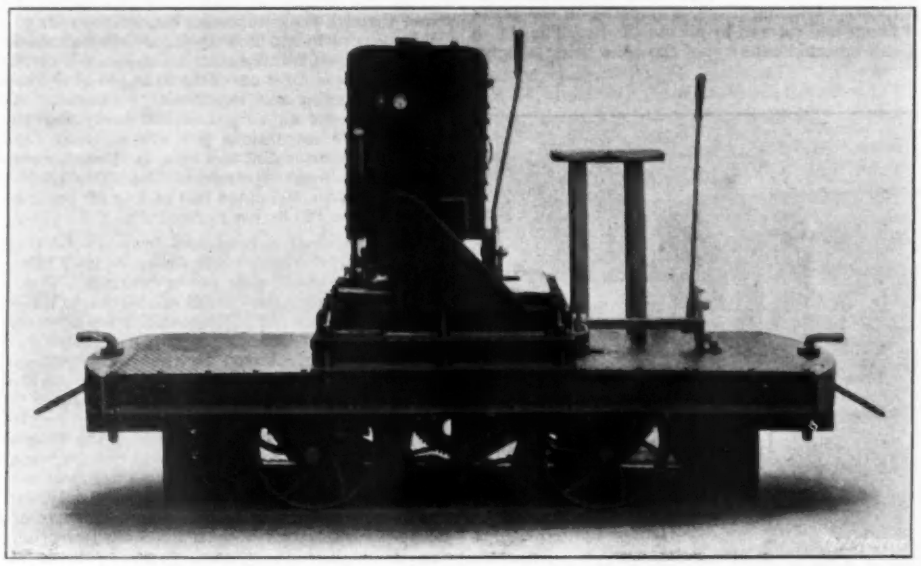


FIG. 7—10 H.P. PETROL SHUNTING LOCOMOTIVE—FOWLER

emptier. All of them have received notice in our pages before. A novelty on the stand is, however, a small petrol shunting locomotive, of which we give an illustration in Fig. 7, and which is furnished with a 10 horse-power engine. The first locomotive of this type was exhibited at the British Industries Fair in February last, but it was only experimental, and since then it has been remodelled. The brake gear, for example, has been re-designed, and the frame, which is built of strong channel irons, has been arranged for gauges from 18in. to 30in., or 45 cm. to 75 cm. The original machine was for 24in. gauge only. The engine and transmission gear are carried in the centre in one unit, with chain drive to both axles. The wheels are of cast steel. Pressure lubrication is used throughout. The whole operation of the locomotive is controlled by two levers, one for the forward and reverse gears, which are operated by clutches, and one for the brake. Messrs. Fowlers put this machine forward as being a simple and economical shunting locomotive for all kinds of contracting work. It will, so they inform us, haul 38 tons on the level or 12 tons up a gradient of 1 in 50.

MARSHALL, SONS AND CO., LTD.

Rollers of various types, concrete mixers, cranes, oil engines and a 4-ton Cummer asphalt plant form the principal features of the stand of Marshall, Sons and Co., Ltd., of Gainsborough. They were all of

FIG. 8—"MANUMIT" MOTOR ROLLER—MARSHALL

types which we have previously noticed. There is, however, one comparatively humble exhibit which we have not seen before. It is what its makers call the "Manumit," and they claim that it is "one of the finest general service light motor-driven rollers which has yet been devised." The model exhibited, which is shown in Fig. 8, weighs 12 cwt., but there is on the stand, too, a somewhat larger model weighing 20 cwt. The power unit is a small two-stroke petrol engine fitted with "petroil" lubrication. Transmission is through a flexible coupling and worm wheel reduction gear, in which ball bearings are employed, no chains or sprockets being used. The final transmission from contact between the idler roller and its inside track path gives the necessary travel. The direction is changed by throwing over the handle. The power unit is swung from the main axle inside the roller. Messrs. Marshall describe it as being "absolutely a one-man machine, with unit control, easy to start, easy to steer, and a thoroughly practical proposition for work of any class where larger and heavier rollers would be prohibited."

RANSOMES AND RAPIER, LTD.

Excavators, a crane and concrete mixers, form the principal features of the exhibit of Ransomes and Rapier, Ltd., of Ipswich. This firm has just introduced a new form of tilting drum concrete mixer which is known as the "7-T." It is illustrated in Fig. 9. The capacity of the skip of this machine for unmixed materials is 10 cubic feet, and the output per mixed batch is approximately 7 cubic feet. Based on a batch every 1½ minutes, which is a speed that, we gather, is easily reached, that represents an output of 80 cubic yards per eight-hour day. Actually, that volume can, so we are assured, be exceeded, an output of 100 cubic yards having been attained. The mixing drum is driven through Hans Renold bushed roller chain by a 6½ H.P. Lister hopper cooled engine, which is magneto fired. The elevating skip is power-operated, and is fitted with automatic knock-out gear, clutch, brake, and single lever control gear. The machine has several novel features, including Ackermann or motor car principle steering, stub axles, automatic and regulating water tank, pivot type skip, &c. It is mounted on four pressed steel disc road wheels.

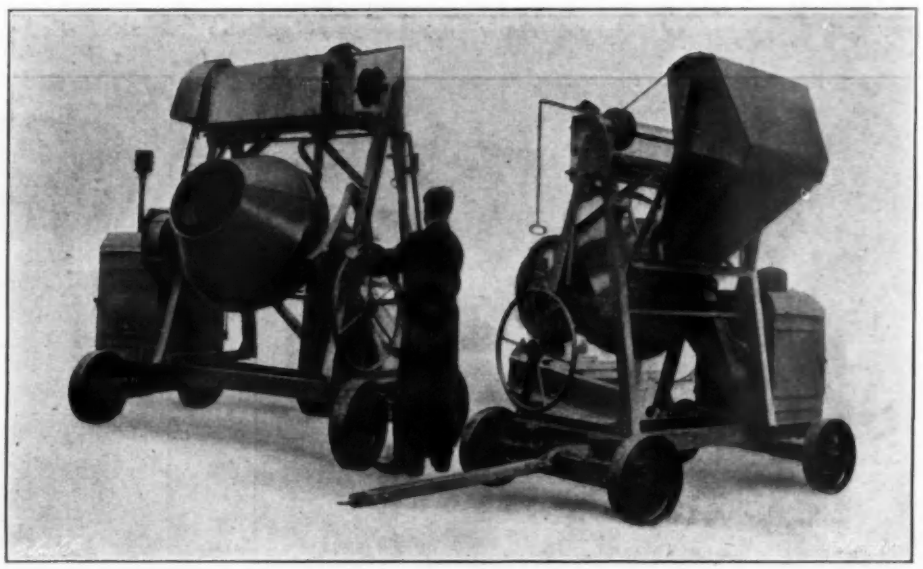


FIG. 9—"7-T" TILTING DRUM CONCRETE MIXER—RANSOMES

TANGYES LTD.

Among the multifarious display of pumps of various types, oil engines of different kinds, jacks, lifting tackle, &c., with which the name of Tangye is so intimately associated, we noticed a new type of fuel oil engine which is being exhibited for the first time. It is actually being made in three sizes, *i.e.*, 2½, 4, and 6 H.P., but the example shown was of 2½ H.P. It is illustrated in Fig. 10. This engine, which works on the two-cycle principle, is intended for such a wide range of purposes as pumping, electric lighting and for the driving of saws, barn and dairy machinery, &c. It can use as fuel, gas oil, Diesel oil, fuel oil and paraffin. Its bed-plate forms the bottom half of the crank case, and is of sufficient depth to enable the fly-wheels, of which there are two, to clear the floor.

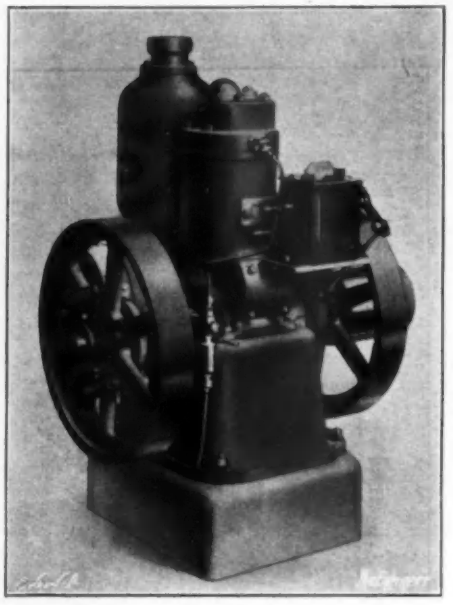


FIG. 10—2½ H.P. FUEL-OIL ENGINE—TANGYES

The cylinder casing is of cast iron, and is in one piece with the top half of the crank case, the joint between the two being machined to ensure air-tightness. The cylinder head and vaporiser are readily removable for examination and cleaning. The connecting-rod, which is a steel stamping, is furnished with a white metal crank-pin bearing, and there is a hard bronze bush for the crank pin. The fuel pump is controlled by an automatic governor actuated from the crank shaft, governing being effected by varying the stroke of the pump plunger in accordance with the load on the engine. Governing is on the variable admission principle, and there is a definite impulse at every revolution whether the engine is on light, medium or full load. Incorporated in the cylinder head is a small vaporiser which has to be heated before starting. The heating lamp, however, only requires to be applied for a few minutes. Forced feed lubrication is employed and the main bearings are of the ring-oiled type. Practically all fuel oils, can, we understand, be used in this engine, provided that they will flow through the pipes and pump without having to be heated.

The overall dimensions of this little engine are:—Height, 31in.; width over crank shaft, 30in.; and depth, 26in.; the net weight is 4 cwt. It is furnished with a pulley 6in. in diameter by 5⅝in. face, and it develops its rated power at a speed of 650 r.p.m.

(To be continued.)

Railway and Road Matters.

ADDITIONAL running loops are to be constructed by the London and North-Eastern between Doncaster and Spalding. The down mineral empties yard at Doncaster is to be modernised and enlarged; an artificial hump is to be laid down.

THE retirement, owing to ill-health, of Mr. Fraser, the Chief Commissioner of the New South Wales Government Railways, was mentioned in this column of our issue of September 20th.—It is now announced that he is to be succeeded by Mr. William Cleary, who, according to Reuter, "is entering the public service at some financial sacrifice."

THE Canadian National Railways are to spend about 3,000,000 dollars at Kingston, Ontario, on a programme of improvements, including the reconstruction of the main line from Collin's Bay into the city, the erection of a new station for Kingston at the junction of Princess-street and the Bath-road, and the construction of a siding into the new grain port on Little Cataraqui Bay, where the Canada Steamship Lines are building a grain elevator.

IN addition to the extension of the Piccadilly tube northwards from Finsbury Park by the Underground companies, that line is to be extended in a westward direction from the terminus at Hammersmith to Northfields. Leicester-square Station is to be reconstructed on the lines of Piccadilly-circus new station, and the Holborn Station on the Piccadilly line and the British Museum on the Central London are to be made into one exchange station.

INCLUDED in the £2,410,474 proposed to be spent by the London, Midland and Scottish Railway in redemption of the abolition of the railway passenger duty is a sum of £508,966 for 30 Garratt engines and 25 freight engines, including additional engine shed equipment required, £407,149 on improved arrangements in connection with signalling, £208,840 on the substitution of electricity for gas in lighting passenger coaches, and £200,000 on strengthening bridges.

IT is stated that the closing of the Blyth and Tyne section of the London and North-Eastern, as regards passenger traffic, is under consideration. Such a step is contemplated because of motor omnibus competition, which, however, will now be less felt by the railway company as an interest in the motor transport has been obtained. The Blyth and Tyne Railway used to be a very fine property. The first section was opened in 1840, and at one time it paid 10 per cent. dividend. The North-Eastern Railway acquired it under powers obtained in 1874.

THE Ministry of Transport railway statistics for August last have recently been issued as a Stationery Office publication, price 3s. 6d. They show that, compared with the corresponding month of 1928, there was an increase of 5·2 per cent. in the number of passenger journeys, but as that increase came wholly from passengers at reduced fares, the receipts from passengers fell by 2·3 per cent.; moreover, there was an increase of 2·6 per cent. in the passenger-train mileage. On the other hand, there was the very gratifying increase of 10·7 per cent. in the tonnage of freight traffic and of 4·93 per cent. in the receipts therefrom. Coal increased by 13·98 per cent. in tonnage and 11·26 per cent. in receipts; other minerals by 10·21 per cent. in tonnage and 0·64 per cent. in receipts; general merchandise increased, though only 2·2 per cent. in tonnage and the receipts fell by 0·45 per cent. The freight train mileage rose by 4·2 per cent., the average train-load from 125¾ to 130¼ tons, and the net ton-miles per engine-hour from 441¾ to 456. The last is a good sign, as it shows that the freight trains got over the line better.

A NEW standard rule book for the Indian State Railways came into force on July 1st. In 1925 a committee was appointed to examine and recommend necessary modifications in the general rules for working open lines of railways in India. The draft revised rules drawn up by the committee were then circulated to the railways for remarks and criticisms. On receipt of them the Senior Government Inspector of Railways was placed on special duty to consider the suggestions of the various railways and the recommendations of the Committee. The re-drafted rules were then considered by the Railway Board, and the revised rules were issued in December, 1927, with a view to bringing them into force with effect from July 1st last. The policy of the Indian railways as to the public knowledge of their rules differs from the British attitude. Here they are kept secret, and only when a relevant rule is quoted in a Ministry of Transport accident report does an outsider learn anything. In India they can be purchased from the Government of India Press. The size of the Indian rule book may be judged from the fact that it consists of 114 pages, foolscap size; there are about 400 headings, 412 rules, 4 appendices, and the index fills 30 pages.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first nine months of the present year was as follows, the corresponding figures for 1928 and 1927 being added in brackets: —Locomotives, £2,259,157 (£2,746,062, £1,464,012); rails, £2,039,605 (£2,677,214, £2,354,946); carriages, £1,722,332 (£2,027,191, £2,457,703); wagons, £1,857,912 (£2,441,263, £2,123,451); wheels and axles, £339,397 (£623,135, £553,080); tires and axles, £401,031 (£440,818, £466,875); chairs and metal sleepers, £366,717 (£730,495, £981,160); miscellaneous permanent way, £781,837 (£1,045,058, £1,137,311); total permanent way, £4,045,665, (£5,613,924, £5,705,175); the weight of the rails exported was 243,303 tons (309,126 tons, 287,773 tons) and of the chairs and metal sleepers 35,755 tons (73,663 tons, 98,194). During September last locomotives of the value of £138,818 were sent overseas, which included:—India, £45,113; the Argentine, £43,018; South Africa, £16,723; other countries than the Argentine in South America, £7129; Straits Settlements, £6804; Ceylon, £5914. During the same month rails of the value of £160,008 were shipped abroad, which included:—South Africa, £62,801; India, £24,205; New Zealand, £14,453; Straits Settlements, £3263; Australia, £1828; Ceylon, £1128.

Notes and Memoranda.

A COMPRESSING plant for driving natural gas along a pipe line is to be built in Louisiana at a cost of a million dollars. It is to deliver into a 20in. and a 16in. pipe some 100 miles long, and it is estimated that the pumps will require 16,000 horse-power.

IN an article in *Engineers and Engineering*, Mr. W. Stainiar, of the American du Pont Company, says that he has recently had manufactured, for the transmission of 850 horse-power, a four-ply leather belt 44in. wide. It runs at a speed of 4200ft. a minute.

THE Burma Railway has undertaken the building of the first bridge across the river Irrawaddy, from Sagaing to Amarapura. The bridge, when completed in 1933, will be 4000ft. long and consist of nine spans of 350ft., one of 250ft., and six spans of 60ft. It will have a clearance above the highest flood level of 40ft.

THE Swedish Academy of Engineering Science is asking for a grant in the next Budget of Kr. 150,000 towards the construction of a trial plant for the production of oil from wood and wood waste. Trials at Swedish laboratories are reported to have proved that the production of oil from wood on the Bergius system is easier than the production of oil from coal.

THE Westinghouse Electric Company, of America, has made an exhaustive investigation as to the relative merits of reciprocating steam engines and turbo-electric sets for driving stern-wheel steamers of shallow draught, and has come to the conclusion that while the capital cost of the turbo-electric plant may be of the order of 93 units, as against 68 for the reciprocating engines, the running costs would be 26 and 32 respectively.

IT seems possible, says the American Bureau of Mines, that for strictly metallurgical or chemical uses, aside from the use for direct production of power, the fields of greatest theoretical interest for the use of natural gas will be the manufacture of hydrogen for ammonia syntheses and the direct reduction of such oxides as zinc or iron. Although the direct manufacture of hydrogen from methane is possible, it seems that the most economic method for producing the pure hydrogen required for ammonia syntheses will be by the action of steam on metallic iron, the iron oxides so produced being again reduced to metal by the use of the natural gas.

A DEVICE for minimising the danger to navigation during a fog at sea is being tested on the Clyde. It is a combination of telephone and foghorn, and is based on the fact that, while sound travels at a comparatively slow rate, wireless signals are substantially instantaneous. When the foghorn of the Cumbrae lighthouse sounds, a wireless telephone transmitter beside it at once begins to count one, two, three, and so on, the interval between each figure representing the length of time that sound takes to travel a mile. When the count begins the wireless operators on ships within range of the foghorn listen for the sound of it. When they hear it, they can calculate from the last figure counted before its arrival the distance the sound has travelled. The device is the invention of the engineer to the Clyde Lighthouse Trustees.

BY utilising the rising tide and an old freight steamer the 800-ton concrete counterweight of the wrecked Hackensack bascule bridge in New Jersey was removed from the river which was closed to traffic for a total time of 12½ hours. The counterweight was dropped into the river when one of the leaves of the bridge failed during lowering on December 15th. The procedure used to remove the counterweight was as follows:—The leaves of the bridge were raised to their fully open position, and the old steamer was manœuvred over the counterweight. The vessel was then filled with water and sunk until at low tide it rested on the counterweight. Divers lashed the concrete block to the steamer by means of cables. Then, as the tide rose, the water was pumped from the vessel, which lifted the counterweight from the bed of the river. Thus suspended from the steamer, the counterweight was towed out of the ship channel and deposited where it would not interfere with navigation.

THE presence of non-metallic inclusions in steel has been thought to be the cause of a large number of defects and failures of steel in use. Because of this belief many investigations have been made dealing with the type, and particularly the amounts, of impurities present. An investigation at the Pittsburgh Experiment Station of the United States Bureau of Mines, in co-operation with Carnegie Institute of Technology and the Metallurgical Advisory Board, has been directed with the hope of quantitatively determining the amount of inclusions present in steel. A large number of extraction methods have been proposed, but have met with only a small degree of success. Some of the reasons for the failure of these proposed methods are that a large number of inclusions are soluble in the reagents and frequently such small samples are used that insufficient residue is obtained for the subsequent analysis of the non-metallic matter. Likewise, no method has been recommended which offers any means of accurate control of the rate of solution of the steel, the solubility of various inclusions, and the type of contamination of the extracted material which necessitates subsequent treatment for removal. Certain electro-chemical principles do, however, offer means for controlling the above factors in such a way that by proper selection of electrolytes, inclusions should be quantitatively extracted from steel and merely require washing and drying to complete the determination. Therefore a method could be devised by the proper selection of an electrolyte, which, of course, involves considerable theory and experimentation. From the work already done in this connection it is known that the electrolyte desired must have a hydrogen ion concentration practically that of water. This in turn necessitates the combination of (OH) ion in a soluble complex so that ferrous and ferric hydroxides will not be precipitated. Also, both the H^+ and $(OH)^-$ ion concentrations must be maintained as constant as possible. An electrolyte of this type necessitates a buffer solution containing a weakly ionised acid and some material such as sodium citrate. Another year of investigation should solve this problem, and in doing so greatly further the larger problem of the formation and identification of inclusions in steel.

Miscellanea.

A FACTORY has been started in Scotswood-on-Tyne for the coating of metal articles with chromium.

UP to the present twenty de Havilland Moth aeroplanes have been sold in China for use by Chinese pilots.

SOME chromite deposits in the Lake Nipigon district of Canada are to be developed by a New York company.

A LARGE oil refinery is to be put up on the north shore of Burrard Inlet, Vancouver, by the Seaside Oil Refinery.

A LINOLEUM factory is to be put up at Farnham, Quebec, by Barry, Ostlere and Shepherd, Ltd., of Kirkcaldy, at a cost of about 2,000,000 dollars.

THE tube works at Vereeniging of Stewarts and Lloyds of South Africa, Ltd., the construction of which was started only two years ago, now have an output of 1200 tons of extruded steel tubes a month.

THE announcement is made by the Japanese Ministry of Railways that printed English translations of the Japanese Engineering Standards (J.E.S.), Nos. 1–26, have now been published in Japan.

OFFICIAL figures show that between 9 a.m. on Monday, November 11th, and 9 a.m. on Tuesday, November 12th, 8·3in. of rain fell at Maerdy Reservoir (Glamorgan). This is a record for England and Wales.

A SERIES of three Cantor Lectures on "Recent Improvements in Methods of Brickmaking" will be delivered by Mr. Alfred B. Searle to the Royal Society of Arts on February 17th and 24th and March 3rd, 1930.

A DEPOSIT of copper glance has been discovered at Messina, Northern Transvaal, at a depth of 40ft. The ore contains over 56 per cent. of Cu, 0·3 dwt. of gold per ton, and 3 oz. 14 dwt. of silver per ton. It requires practically no sorting.

THE Ironmongers' Company has made a grant of £800 a year for seven years to provide a fellowship and two scholarships for research work in cold-rolled steel in Sheffield. The plant, applicances and buildings have been provided locally.

A FURTHER course of lectures on tropical hygiene for men and women (outside the medical profession) proceeding to the tropics will be given on 4th, 5th, 6th, 9th, 10th, 11th, 12th, and 13th December from 5.30 p.m. to 7 p.m. at the London School of Hygiene and Tropical Medicine, Keppel-street, Gower-street, W.C. 1.

IN order to revive industry in the Shantung province of China, the Provincial Department of Commerce and Industry has decided to construct three model factories in the province, one at Poshan, which will be devoted to pottery making, one at Chowtsun for dyeing and weaving, and another at Tsinan, which is to be the centre of the iron and steel industry in Shantung.

IT is announced that the Chinese National Reconstruction Committee has decided to exploit the rich mineral resources of Anhwei province, especially the coal deposits in the districts of Hweiyuan, Shaohsien and Fengtai, in northern Anhwei. To hasten the development of the mines, private investment of capital in the Government enterprises will be accepted. Work on the mines is expected to be started in December and to be continued for a period of 3 years. According to estimates submitted by experts, profits from the annual output of coal alone from the three districts will amount to over £100,000.

AN interesting salvage vessel for the Royal Italian Navy has recently been launched at the Venice shipyards of the Società Italiana Ernesto Breda. The ship is named the "Jason," and her purpose is to aid sinking ships and to raise foundered vessels by the use of compressed air. She is equipped with elaborate apparatus for illuminating the bed of the ocean and for diving operations, and her machinery includes cable-laying and repairing plant. The capacity of the salvage pumps is 3000 cubic metres of water per hour, and it is stated that the ship will be able to tow simultaneously any two of the Italian Navy's cruisers.

THE British Commercial Secretary at Madrid has furnished a translation of Decree-Law No. 1956, of September 7th, 1929, under which a Council of Electric Energy, working under the Spanish Ministry of Public Works, is established. The duty of the Council is to investigate and co-ordinate hydro-electric schemes. The Decree-Law does not apply to concessions already granted, but makes provision, in general, for State control of future developments of electric energy in Spain. A translation of the Decree-Law may be consulted at the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

A CONTRACT has been entered into for building new port works at Asunción, in Paraguay, the old port having long ceased to meet the needs created by the heavy increase in river traffic with Argentina. It is proposed to make Asunción one of the foremost ports in South America. The town is situated 1200 miles from the ocean and is nowhere higher than 250ft. above sea-level. The new works, into which reinforced concrete will enter largely, will comprise roofed piers with a total length of 1200 m., equipped with electric cranes, narrow-gauge railway lines for port service and extensive landing places. A preliminary estimate of the cost is 2,500,000 gold dollars (£500,000). A time limit of ten years for completion is imposed.

ON November 28th, the British Electrical and Allied Manufacturers' Association will publish an important survey of the economic position and organisation of the British electrical industry. It represents the work of almost two years' continuous economic research into the main factors governing the growth of the industry and the development of its present predominance in export markets. It discusses in detail the modernisation of equipment in the basic industries, and shows how, through electrification, a new period of economic prosperity should take place in this country. The monograph also contains proposals advanced on behalf of the electrical industry for the expansion of production at home and the strengthening of the competitive position abroad.

UNIV. OF MICH.

THE GRIMSEL HYDRO-ELECTRIC POWER SCHEME

(*For description see page 540.*)

FIG. 7—THE SEEUFEREGG DAM, AUGUST, 1929

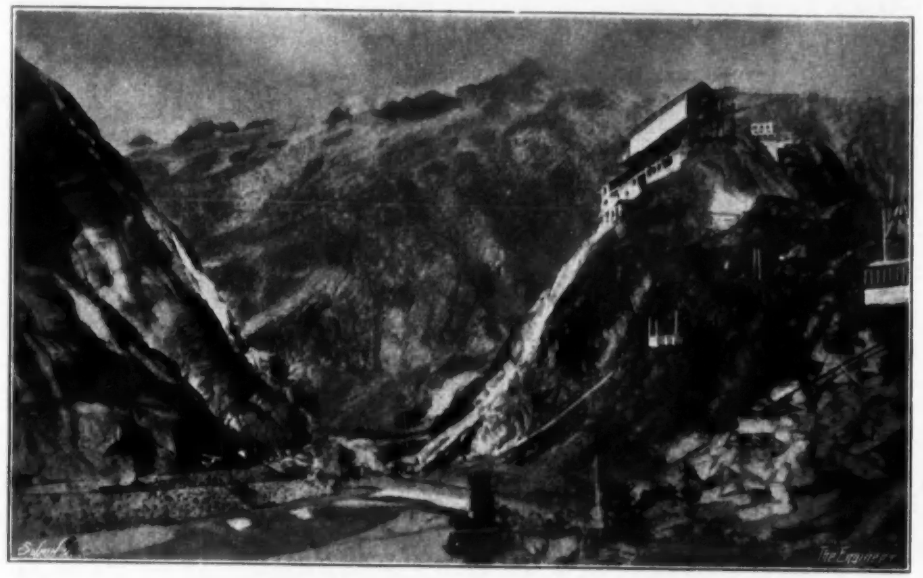


FIG. 8—THE SPITALLAMM DAM SITE, 1927

FIG. 9—THE GELMER DAM, AUGUST, 1929

FIG. 10—HANDECK, THE POWER STATION

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NOTICES TO READERS.

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THE ENGINEER.

NOVEMBER 22, 1929.

The Taxation of Industry.

YEARS ago the false theorem that the more you taxed industry the more it would flourish got into circulation. It sprang from the events in England which succeeded the Napoleonic wars, and has remained in currency till this day, despite the fact that it has been proved categorically false. The conditions in England after 1815 were very different from those which prevail now after the Great War. Then we had safe markets on which we could count; now we have none abroad, and very few at home, which we can regard as our own. Then we ran the workshop of the world; now every great country is its own workshop. Then it paid to spend money on the development of inventions because the return was certain; now the expenditure may prove fruitless in the face of foreign competition. Then we possessed the best engineers and the best mechanics in the world; now we have taught all the nations of the earth, and they are as good as their masters. The very post-war taxation which encouraged industry in the early part of the nineteenth century is having the opposite effect in the present century. It is stopping progress by so increasing the costs of manufacture that surplus profits are few. It is assisting the adoption of foreign inventions because our own engineers cannot find the money for costly experiments, and it is adding to the volume of unemployment because the taxation so increases the cost of manufacture that successful competition in foreign markets is hard instead of easy.

There is no escape from these economic facts; it is patent to all that unless we can reduce the price of our goods we shall never regain our position on markets which were once ours, and which are an absolute necessity to us. The engineering industry and those allied with it are more deeply concerned in this matter than any other. They are suffering more than any other; they are unable to pay the wages that they ought to be able to pay, and they are having the greatest difficulty to make both ends meet. They are the principal industries of the country, the backbone of its foreign trade, and the most complacent of its sufferers. They pay their taxes and imposts like good citizens, but—unlike good citizens—they are not ceaseless and unwearying in pointing out whither excessive taxation is leading them. "I want to suggest," said Sir Gilbert Vyle in an admirable after-luncheon address to the members of the British Engineers' Association a week ago. "I want to suggest to the engineer that it is time he lifted his eyes from his drawing-board and took his nose away from his own particular task, and gave just a small fragment of his time to considering what are the external forces that come in and nullify and destroy every effort which he makes in the efficient conduct of his own business." In a few illuminating figures Sir Gilbert showed the burdens under which industry is labouring. He showed that the British National Debt is 10·6 times as much as it was in 1914, whilst in France it is only three times; in Germany, after losing the war, it is still far less than in this country. In the United States it is less than half that of the United Kingdom. Turning to the national income, Sir Gilbert gave it for Great Britain as 4164 and for the United States 18,520 millions of pounds sterling; the income per head in England is £91·5, in America £154. Yet here we spend 820 millions for government, interest, pensions, &c., and there—with a population three times as great—the expenditure is only 749 millions. In other words, with an income four and a half times as big, the United States spends 70 millions less for government than we do. On social services we spend no less than 383 millions a year, including pensions. Out of this vast sum unemployment insurance costs 56·23, national health 40·9 millions, widows' and orphans' pensions amount to 7·5, old age pensions 30·8, war and Ministry pensions 60·2, education 93·27, public health 10, relief of the poor 55, and housing of the working classes over 22·7, as compared with 0·88 in 1911. There remain 6 millions which go on other Acts relating to social services. To sum up, we are spending approximately 9 per cent. of our income in social services. Let us look at it in another way. In a pamphlet just circulated by Sir G. B. Hunter we find these figures. Taxation in Great Britain has been increased from £3 11s. 4d. in 1913 to £14 1s. 8d. per head, including men, women, and children, in 1927. In Germany it is under £6 per head, and in the United States under £4. On social services we are spending £3 18s. 6d. per head as compared with 13s. per head in France and only 3s. 6d. per head in Italy. We may illustrate the effect by a recent figure from the iron and steel industry. Every ton of iron and steel has on the average to bear a burden of 4s. 3d. for social services alone, and before rating relief came into force it had to find 4s. 7d. per ton for local rates and taxes. We are now threatened with an addition of something like 12 millions to the expenditure on social services, and in all probability further taxation, so that the first of these figures will be increased.

If this unparalleled expenditure upon social services was effecting a really desirable and useful purpose, and if the country could afford it, we should be the last to complain of it. But it is not only failing to give happiness and more contentment to the country, but it is undermining the very source from which those desiderata are drawn. The contented country is that which gives occasion for effort and rewards effort adequately. In the engineering industries the available man power is not fully employed, and the wages are lower, by general agreement, than they ought to be by comparison with unskilled trades. The prudent course would be to encourage industry by the reduction of taxation, for by so doing a great deal of the necessity for social services would disappear automatically. We submit that the ideal condition is one in which no one is dependent upon State aid for anything, but is able by his own endeavours to supply all his own wants—even for education. That ideal may not be attainable, but the country will only get further and further away from it by the continual increase of burdens which lie heavily upon industry, prevent its development, and make it impossible to pay wages on a scale sufficient to make every man a self-reliant citizen. Mr. Baldwin took a step in the right direction when he reduced the weight of the rates upon industry; the present Government appears to be determined upon a move in the opposite direction. Increased taxation, in whatever way it is applied, must almost inevitably have the effect of still further hampering industry by augmenting the cost of manufacture.

Large Ocean Liners.

TWELVE months ago the newspapers were teeming with reports of the impending construction of mammoth liners for the Western Ocean service. We seemed to be on the eve of an international competition for the "blue riband" of the Atlantic,

transcending in magnitude and intensity all previous contests of this kind. Public interest was stirred by the vision of a whole fleet of monster ships setting out to establish new records for the ocean crossing. In a few years, it was confidently affirmed, even the mighty "Majestic" and "Leviathan" would be relegated to secondary rank, and the best steaming performances of the "Mauretania" left far behind. These expectations, however, are not yet within sight of fulfilment. As regards progress in big liner construction the present year has been singularly blank. No super-ship has been laid down in Europe or America, nor does it seem likely that any will be started in the immediate future. It is true that plans exist for over a dozen great liners, British, Continental and American, but the mere fact that a ship has been designed is no guarantee that she will be built. The only event of positive importance which has happened this year is the completion and maiden voyage of the Norddeutscher Lloyd liner "Bremen." Her sister, the "Europa," it will be recalled, was so severely damaged by fire at Hamburg last March that she will not be ready for service before the spring or summer of 1930. The "Bremen" sailed on her maiden voyage in July, and reached the Ambrose Channel lightship off New York after a run of 4 days 17 hours 42 minutes from Cherbourg breakwater. This ocean passage of 3096 nautical miles at a mean speed of 27·83 knots was the fastest that had ever been made. On her return trip the "Bremen" did even better, crossing from New York to Plymouth at an average speed of 27·9 knots. In none of her later voyages has she equalled this performance, but it is not unlikely that she may create new records when her machinery has been thoroughly bedded down and "run in." Although any suggestion of a race has been disclaimed both by the Norddeutscher Lloyd and the Cunard people, it was a coincidence that, a few days after the "Bremen's" performance, the "Mauretania" should have steamed across the Atlantic in shorter time than she had ever done during her twenty-one years' of service. Leaving Southampton on August 3rd she reached New York in 4 days 22 hours 44 minutes, having steamed the whole distance at an average speed of 26·85 knots. For twenty-four hours she maintained a mean of 27·48 knots, in spite of unfavourable weather. This extraordinary feat has not unnaturally suggested to the public that the old veteran still has a knot or two in reserve, and may even yet beat her young German rival. But, as Sir A. F. Yarrow pointed out in a recent letter to the Press, it is not fair to compare a vessel over twenty years old with one newly built, especially when the latter has an advantage of 160ft. in length and is fitted with water-tube boilers, as against the old-fashined cylindrical boilers of the Cunarder. In our opinion, the "Mauretania" has done all, and far more than all, that could reasonably be expected of her, and there is, we fear, no chance of her recapturing the "blue riband." If our shipowners attach any importance to the possession of that trophy, they must be prepared to build new ships which would incorporate, to an even greater degree than the "Bremen," the latest developments in hull design and propelling machinery.

Considering what our shipbuilders and marine engineers have accomplished in the past, there can be no question of their ability to turn out new record-breaking ocean liners. The fact that such vessels have yet to go afloat is due entirely to economic considerations. The laws of demand and supply apply just as much to shipowning as to any other branch of business. Ships of such outstanding size and speed as the "Mauretania" and "Lusitania," the German "Imperator" class, and, more recently, the "Bremen" and "Europa," were built in response to a definite demand. In every case they replaced vessels which were no longer equal to the requirements of the passenger traffic for which their respective owners catered. At the present time, however, the principal British liner companies do not, apparently, see any immediate necessity for the construction of very large and very fast ships. Their existing fleets, we understand, proved quite adequate to deal with the traffic requirements of the past season, and the appreciable decline in the number of first-class passengers on the cross-Atlantic route, as compared with last year's figures, is scarcely an inducement to embark on costly programmes of new construction. The slump in big liner construction is just as evident abroad as at home. In this country all work has been suspended on the White Star vessel "Oceanic," of 60,000 tons, since her keel-plates were laid at Belfast in June, 1928. The company, it is understood, is still considering alternative methods of propulsion, but in view of Lord Kylsant's public statements there is little doubt that the vessel will be equipped with either oil-electric or turbo-electric drive. It is possible that the designers have taken advantage of the delay to touch up the original plans, in which case the new "Oceanic" may turn out to be an even more imposing ship than had been anticipated. This month there has come an official denial from one of the Cunard directors that his company had contracted with well-known firms in the North for two large liners. On the other hand, there has been no contradiction of the report that the Cunard line has in view the building of vessels which are likely to establish new standards of tonnage and speed. Turning to other countries, there is still no news of the laying-down of the Cie. Générale Transatlantique liner, which was reported last summer to have been ordered from the famous yard at St. Nazaire. She is to be larger than the "Bremen," and a contract speed of 27 knots has been mentioned. In Italy the Navigazione Générale Italiana and the Lloyd Sabaudo have each in prospect a 50,000-ton ship faster than the "Bremen," but so far neither vessel has been started. On the other side of the Atlantic the Chapman Company, which purchased the "Leviathan" and other units of the United States Lines, are inviting tenders for two 30,000-ton ships of 24–25 knots. These comparatively unambitious ships are to be built before the two "super-Leviathans," of 55,000 tons, which would appear to have been shelved for the present. It is certainly not a fortuitous circumstance that the building of all the very large liners projected last year has been postponed. We have already alluded to this year's serious shrinkage in first-class passenger traffic, but there are other considerations which cannot have failed to weigh with the liner companies. Despite the fact that in recent years the number of first-class passengers annually carried across the Western Ocean has been about 100,000 less than the pre-war average, the total tonnage of the vessels plying on this route to-day is only slightly less than the total in 1913–14. It would seem, therefore, that the supply has outrun the demand. There is always a section of the travelling public which is ready to pay high fares for the privilege of rapid sea transport, but whether such people are numerous enough to justify the building in the near future of a whole series of very fast ships is exceedingly doubtful. Added to the formidable first cost—which in the case of a 60,000-ton, 28-knot ship might be as much as £4,000,000—the operating charges are necessarily very high. The "Bremen," for instance, is said to consume 6000 tons of fuel-oil on each round trip. Harbour and dock dues constitute another serious item in the bill. So onerous are these charges at New York that the Cie. Générale Transatlantique is seriously considering the choice of an alternative terminal on the North American seaboard. While there is natural jubilation in German shipping circles at the splendid performance of the "Bremen," doubts are being freely expressed as to whether this ship and her sister will prove a sound investment from the purely commercial point of view. It is significant that the Hamburg-Amerika Line, which is second to none in experience and enterprise, has definitely decided against the building of fast liners. The directors of the company, it has been intimated, consider that ships of medium tonnage and speed, combining comfortable accommodation with moderate fares, are better adapted to present-day requirements.

Taking as we do a professional interest in the advancement of shipbuilding and marine engineering, we cherish the hope that economic conditions may soon improve to the extent of warranting the construction of some, if not all, of the great liners which are known to have been designed at home and abroad. The launching of ships which will eclipse the "Bremen" as completely as the "Mauretania," twenty-two years ago, eclipsed all other aspirants for the ocean speed trophy, is merely a matter of time. Writing in no spirit of national prejudice, but simply from knowledge of current progress in naval architecture and engineering, we do not hesitate to predict that Britain's next great ocean liners will worthily uphold the traditions of the twin industries, which exemplify, in a peculiar degree, the mechanical genius of our race.

THE Mining Machinery Laboratories at the Birmingham University were opened on Wednesday, the 13th inst.

Literature.

Engineering for Masonry Dams. By WILLIAM PITCHER CREAGER, M. Am. Soc. C.E. Second edition. 1929. London: Chapman and Hall, Ltd. Price 20s. net.

THE first edition of Mr. Creager's book is well known as a work which helps the designer and the executive engineer to understand the nature of the problems which have to be solved in the planning and carrying out of dam building, to make the necessary calculations, and to decide, with the defined purpose in view, as to how far reliance may be placed upon experience of similar works or to what extent certain theories of mathematicians and conclusions of investigators need be accepted.

It is to be regretted therefore that, in the present edition, the author has failed to maintain this feature in relation to some important developments of theory and design, and useful results of experiment and experience. It is true that the attention of the reader is directed to some of the pertinent information, as in the case of calculations of stresses in arch dams or the results of the tests on the experimental dam at Stevenson's Creek, but the relations of those results to theory and to experience is so obscurely expressed as to be misleading, while no allusion is made as to certain important verifications of inferences drawn from earlier studies. A similar criticism must be made in respect of the multiple arch dam, as a class including many important and not a few unsatisfactory structures. This class is not presented amongst the "usual types," six in number, listed by the author, but is accorded half a page in the chapter on the design of arch dams.

The author has revised the text and added new matter, largely drawn from "Hydro-electric Handbook"—Creager and Justin*—and including the useful chapters on the Design of Arch Dams and on Flood Flows. With the exception of the Stevenson Creek experimental or test dam, the table of arch dams does not include any of later date than 1914; but the chapter extends the scope of the book, while that on flood flows, with its 409 cases of unusual flood discharges in the United States, furnishes valuable data. There is not, however, any corresponding expansion of the book in respect of the materials and methods employed in building the main body of a mass dam, although some interesting modifications of earlier practice or adoptions of methods followed in the construction of obscure works, have been employed during the past ten years or so on works of importance. The nine pages accorded to Masonry for Dams, including Concrete, are included in a chapter on Details and Accessories—inadequate treatment, having regard to the purpose of the book.

In spite of its shortcomings, and the fact that some of the fresh matter has been separately published, Mr. Creager's book is worth the attention of senior engineers, as an aid to the reconciling of theory with practice, and as furnishing carefully worked-out examples of the design of typical dams. It is of more value to the young engineer who is entering upon the stage of responsibility for the location, design, and execution of works, for the data furnished are well chosen, the discussions of essential matters are very practical, and the book, as a whole, is an aid to that organisation of the engineer's own mind and private notes, which should precede his entering upon designing or executive work.

BOOKS RECEIVED.

Railway Control by Railway Stockholders. By G. A. Nnokes. Sussex: The Bordyke Press, Burgess Hill. Price 1s. net.

Mechanics of the Gyroscope. By R. F. Deimel, M.A. London: Macmillan and Co., Ltd., St. Martin's-street, W.C. 2. Price 17s. net.

Transactions of the Institution of Chemical Engineers, Vol. 6, 1928. London: The Institution of Chemical Engineers, Abbey House, S.W. 1.

The Ford Model A Car: Construction, Operation, Repair. By V. W. Pagé. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 10s. 6d. net.

New South Wales Government Railways and Tramways: Report of the Commissioners for the Year ended June 30th, 1929. Sydney: Office of the Railway Commissioners for New South Wales.

Metropolitan Water Board, Twenty-sixth Annual Report, dealing with the year ended March 31st, 1929. London: P. S. King and Son, Ltd., 14, Great Smith-street, Westminster, S.W. 1. Price 5s.

Modern Aviation Engines: Design, Construction, Operation and Repair. Two volumes. By Major V. W. Pagé. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 25s. per volume, or 45s. the pair.

Report of the National Screw Thread Commission. Revised 1928; as approved June 22nd, 1928. Washington, D.C. The Superintendent of Documents, U.S. Government Printing Office. Price 50 cents net.

Forest Products Research Bulletin No. 3, British Hardwoods: Their Structure and Identification. By L. Chalk, M.A., D.Phil., and B. J. Rendle, B.Sc., A.R.C.S. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 5s. net.

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* Reviewed in THE ENGINEER, July 8th, 1927.

Commercial Motor Show at Olympia.

No. III. (*Conclusion*).*

In our first article on the Commercial Motor Show reference was made to the efforts which are being made by continental engineers to adapt the Diesel engine and its modifications to heavy transport on the roads. Our remarks were prompted by the exhibits of three well-known makers, all of foreign origin, who claim that, by the use of crude oil as the source of motive power, a saving in the running cost of something like 70 per cent. is obtained compared with petrol. The chief drawback to the use of crude oil engines for this purpose is their weight, which is much in excess of that of the petrol engine, but with the higher speeds of revolution which are now being obtained from this type of motor the weight is being correspondingly reduced.

Crude Oil Engines.

The Mercédès-Benz engine, which was shown fitted to chassis exhibited by British Mercédès-Benz, Ltd., 37, Davies-street, London, W. 1, employs a pre-combustion chamber in which the fuel undergoes a process of partial combustion before it is introduced into the working cylinders. The extra pressure thus generated in the pre-combustion chamber drives the mixture of fuel and air through a special burner into the combustion chamber proper, where it is immediately mixed with more air. The addition of the pre-combustion chamber obviates the necessity to use a compressor. The Mercédès-Benz engine has six cylinders, 105 mm. bore by 165 mm. stroke, and at 1300 revolutions per minute generates 70 brake horse-power. It has a cast iron detachable cylinder head, which contains the inlet and exhaust valves, the atomisers and the pre-combustion chamber. The overhead valves are operated by push rods and rocker arms. The crank shaft is of great strength and is carried in seven bearings between the two halves of the crank case. The connecting-rods are of section steel and the pistons are made in three parts, namely, the body of the piston, of cast iron; the head, of steel; and a heat deflecting plate, of aluminium. The gear wheels of the two auxiliary shafts also engage in the cam shaft drive gear wheel, and of them the upper one drives the fuel pump. On the lower auxiliary shaft is also mounted a centrifugal governor, which acts on the fuel pump and cuts off its fuel supply when a pre-arranged speed of revolution has been reached.

Each cylinder has its own fuel pump and all the pumps are contained in one housing. The pumps have a constant stroke and supply the fuel through a pressure line to the atomiser, which sprays it into the pre-combustion chamber. At that point the fuel passes a back-pressure valve, which prevents the pressure line being completely emptied of oil when the overflow passage is open. The amount of oil delivered by the pump can be regulated as in ordinary motor vehicles by a hand lever and accelerator pedal. A second lever on the steering wheel adjusts the timing of the injection. The oil is delivered to the fuel pumps under pressure by another pump from the tank. The engine is started just as in the case of the petrol motor, but when cold incandescent heaters, which project into the pre-combustion chamber, are employed. These heaters are actuated from a battery.

The Berna engine is built in Switzerland under Deutz licence. It is of the solid injection, pre-compression type and has six cylinders, and those of the 80 horse-power unit are 115 mm. bore by 170 mm. stroke, the normal speed being 1300 revolutions per minute. The cylinders are built in pairs and have detachable heads. The exhaust and inlet valves are fitted in the heads, and at the side of each combustion chamber is a pre-combustion chamber. The engine is started by an electric motor and incandescent plugs in the cylinder heads operated by a push button on the dashboard. The fuel for each cylinder is provided by a simple form of plunger pump with a suction and delivery valve. The plungers are operated by a cam with an inclined profile which regulates the quantity of fuel in proportion to the demand. The injection of the fuel into the combustion heads is governed by flat-seated needle valves. The oil is injected at a pressure of 75 atmospheres first into a small ante-chamber, the cubic capacity of which is about one-fifth of the total combustion space. In this ante-chamber catalytic ignition of the charge takes place, and when the engine is idling it is claimed that only 20 per cent. of the normal fuel supply is required. On load the ignition takes place in the pre-combustion head, from which the fuel is blown in an atomised condition into the large combustion chamber to which the flame promulgation extends. The incandescent plugs are heated by current drawn from the starting battery.

The Saurer Commercial Vehicle Company, Ltd., Augustus-street, Albany-street, London, N.W. 1, in addition to petrol-engined vehicles, showed a 7–8-ton chassis propelled by a heavy oil engine, of which we give illustrations in Figs. 19 and 20. There is something very attractive about the lines of this engine and chassis. The six cylinders have a bore and stroke of 110 mm. by 150 mm. and the engine has a three-point suspension on rubber sleeves. The cylinders are in one casting with the crank case, thus ensuring rigidity and absence of transverse vibrations of the cylinders. The bores of the cylinders are fitted with steel liners, which can easily be replaced when worn, thus avoiding the use of oversize pistons and re-grinding. The cylinder head is detachable and carries the valves and part of the valve gear. This form of construction permits the combustion chamber to be machined, thus ensuring uniform compression. Air storage or turbulence chambers are also fitted in the cylinder head and are easy of access. The valves are vertical and are operated by rocker arms and push rods from the cam shaft in the crank case. Lubrication is thorough, the cam shaft running fully immersed in oil, and all the valve gear is enclosed by an aluminium cover. The pistons are made of a special alloy and are exceptionally long in order to distribute the lateral side pressure over a large area. The crank shaft is unique, consisting of seven sections, which are bolted together. The ends of the sections are flange shaped and carry the main roller bearings. It is claimed that these wide flanges ensure perfect rigidity when they are bolted together. A feature of this form of construction is that each section can be perfectly heat-treated and hardened. The crank shaft is carried in seven roller bearings and is fitted with a vibration damper at the front end. It is drilled throughout for lubrication purposes.

The solid injection system is adopted and the engine operates on the four-stroke cycle with separate air storage chambers. For the injection of the fuel a Bosch injector pump and nozzles are used. These are of simple design and very accurately made. The injector pump situated on the offside of the engine is driven through reduction gearing; by adopting a special shape of the ends of the pump pistons the quantity of oil injected can be regulated within very fine limits. The return valve in the pump cylinder is constructed so as to prevent any dribbling from the nozzles. A fuel filter, easily demountable, is provided to segregate any grit, water, or air before the fuel enters the injector pump. The nozzles are fitted in the cylinders at such an angle as to lead the sprays in the direction of the air flow to the air storage or turbulence chambers. This takes place on the up-stroke of the piston following the suction stroke. The makers claim that by this method the dispersion of the fuel in the air currents is perfect. The ignition of the fuel is effected by the high temperature of compression of the air charge. For starting up from cold by means of an electric starter electrical heating plugs are inserted in the cylinders. An automatic double-acting centrifugal governor regulates the amount of fuel injected in accordance with the load. This engine gives an output of 83 brake horse-power at a speed of 1600 revolutions per minute.

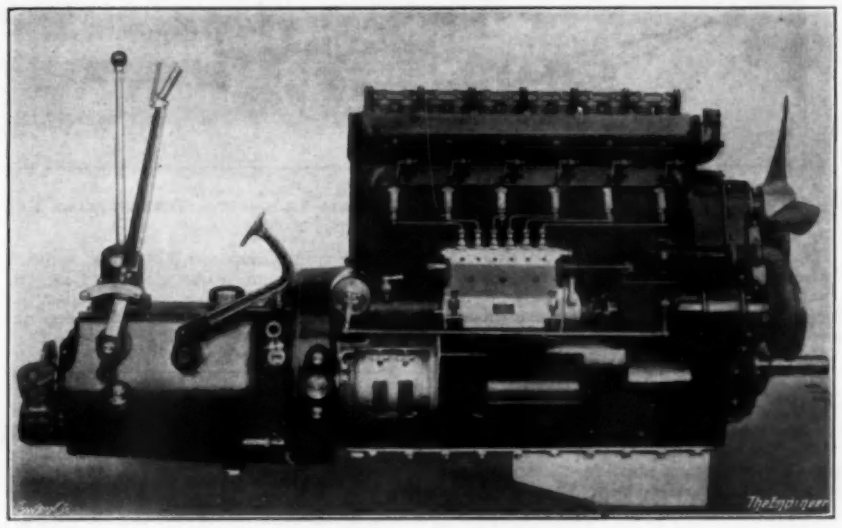


Fig. 20—80 H.P. Solid Injection Engine—Saurer

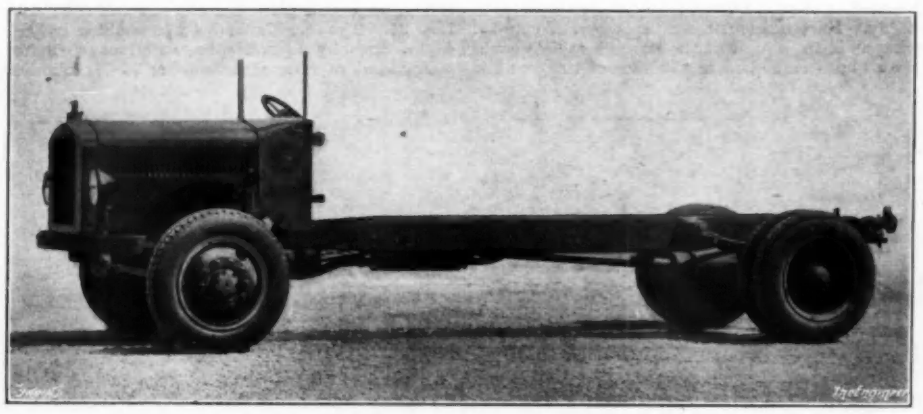


Fig. 19—7-8 Ton Chassis—Saurer

Commer Cars.

This well-known Luton firm is now affiliated with the Humber and Hillman companies. It has celebrated the merger by the introduction of four new 6-cylinder vehicles for both passenger and goods transport. A feature of these new vehicles is the provision of a four-speed gear-box with a quiet, direct drive on both the third and fourth speeds. The third speed being comparatively high, easy of engagement and silent, the designer was enbled to arrange the top gear with a higher ratio than usual, namely, 5·8 to 1. In all the 6-cylinder models, the supply of petrol is provided by a diaphragm-type of pump instead of by vacuum feed. Under-slung semi-elliptic rear springs are also used on the passenger vehicles.

R. A. Dyson and Co., Ltd.

An interesting vehicle was exhibited by R. A. Dyson and Co., Ltd., of Liverpool and 82, Mansell-street, London, E. 1. It is a special truck which is intended for the transport of heavy electric transformers weighing up to 110 tons. This vehicle is of the straight-out flat top type, its loading platform being 22ft. long by 8ft. wide, and the height to the top of platform is not more than 42in. This, it is claimed, is an achievement of considerable merit, because the main frame had to be superimposed upon two bogies, and allowance had to be made for road cambers and irregularities, such as culverts, &c. As will be seen from the illustration Fig. 21, there are eight axles, of 40 tons tensile steel, each having four wheels 20in. diameter, fitted with two "British Goodrich" solid rubber band tires. The wheels are of electric cast steel and the inner wheels on the rear of each bogie have brakes of the maximum diameter possible, operated by hand wheels and compensated. These brakes are 19in. diameter by 3in. wide and there are eight pairs of them.

The front axles are of special design, in that their brackets pivot around machined cylindrical castings secured longitudinally so that the wheels can conform to inequalities. It is claimed, in fact, that the vehicle is entirely flexible under all road conditions. The axles are secured by an ingenious taper cone arrangement with large securing nuts. The wheels are fitted

* No. II. appeared November 15th.

with "SKF" ball bearings, RM. 44, RM. 38 and RM. 32. As a matter of interest it may be mentioned that the weight of the bearings alone is not less than 1900 lb. The two bogies are constructed from double channel steel reinforced by 1in. plate between the two, the various brackets being almost entirely secured by means of 1¼in. diameter turned steel bolts, all of which were machined from the solid and made a driving fit.

Steering is effected by a novel patented arrangement consisting of a large bracket to which is attached a massive draw-bar, and which is hinged to a cast steel bracket on the front of the bogie. The draw-bar bracket is connected to a cast steel track bar by means of a centre pin which operates in a slotted hole in the draw-bar bracket, to allow for the variation in lengths as the vehicle goes into lock. The second bogie is fitted with similar steerage brackets, but is coupled to the leading bogie by a pair of telescopic draw-bars which steer the second bogie to follow almost exactly in the track of the leading bogie. A diagram showing the tracking of the wheels when turning is given in Fig. 22. On the second bogie is fitted a hand steering mechanism which can be operated by means of a hand wheel at each side of the bogie and which, by means of wire ropes arranged to operate on the draw-bar bracket, can be made to steer the rear bogie when the vehicle is required to negotiate exceptionally awkward gateways or turnings. This gear in straightforward work is, of course, disconnected. Tecalemit greasers are fitted throughout the vehicle.

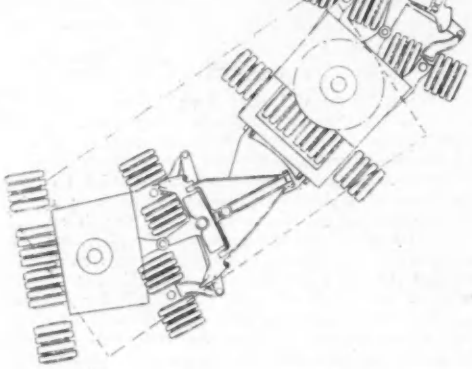


FIG. 22—DIAGRAM SHOWING TRACKING OF WHEELS

The bogie tops are made perfectly flat, so that, when the platform is removed, each bogie can be used separately for loads up to 60 tons each if required.

The main frame and platform are built up of heavy H-section steel joists strongly reinforced and fitted longitudinally, and the platform is fitted with ½in. steel plates having closely fitted planed edges to give additional strength in compression. The number of the longitudinal members had to be great, for, in order to keep down loading height, the joist had to be as shallow as possible in section.

The platform is mounted on the two bogies by means of a cast steel trunnion bracket at the centre, which operates on a phosphor-bronze liner. The platform is fitted with brackets which are machined from end to end to take 6in. diameter high-tensile steel shafts. On these shafts are mounted steel rollers bushed with phosphor-bronze which operate on the flat steel tops of the bogies. The outer side members of the platform are fitted with strong hooks and rings for binding down loads.

The builders point out that a prominent feature of this vehicle is the extreme smallness of its turning radius, which is not more than 24ft. to the centre of the trailer. It had, they inform us, originally been intended to incorporate a double-cranked frame, somewhat on the lines of the railway crocodile trucks. The length, if that means of construction had been adopted, would, however, have been somewhat over 50ft. as a minimum to give a loading platform of 20ft., and the height, even then, could not have been less than 32in. from the ground, and it was considered that a vehicle of such a length would have been quite unweildy. Furthermore, the advantages of coupled steering as incorporated in the present vehicle could not hav been embodied in a trailer of the cranked frame type. A further disadvantage of that type would have been that the load would not have been accessible for handling on and off the vehicle. It is possible to operate this trailer from either end.

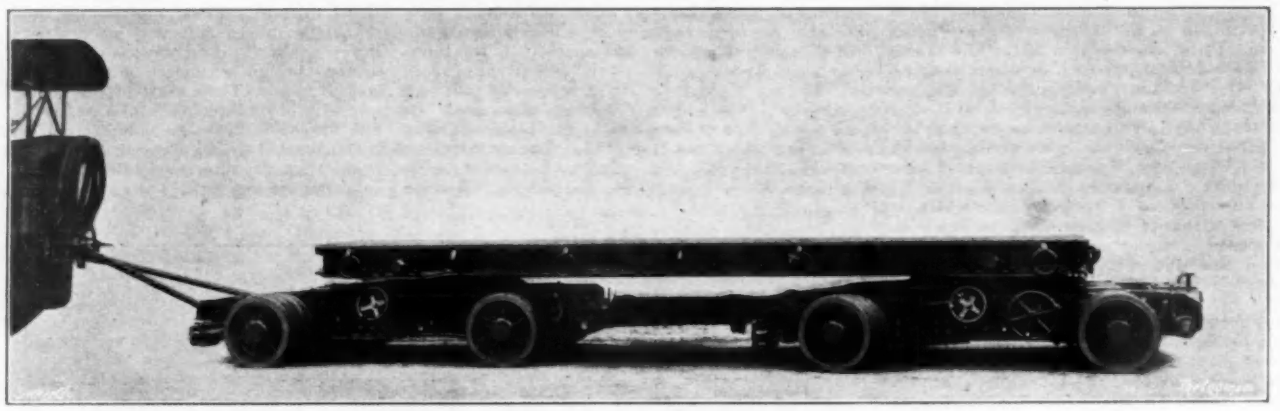


FIG. 21—DOUBLE-BOGIE TRUCK FOR TRANSPORTING HEAVY WEIGHTS—DYSON

LEYLAND MOTORS.

The Leyland Company's exhibits included a four-cylinder "Lion" single-deck omnibus, a six-cylinder "Titan" double-deck omnibus, a six-cylinder "Buffalo" 6-ton chassis of new design, and a 12-ton rigid six-wheeler, also of new design, called the "Hippo." A view of the "Hippo" lorry is given in Fig. 23, and a plan and elevation in the drawing, Fig. 24. The engine has six monobloc cylinders, 4 5/16in. bore by 5½in. stroke, rated at 49·8 horse-power, and capable of developing 72·7 brake horse-power at 1000 revolutions per minute. The engine will, it is stated, run smoothly, however, at from 200 to 2000 revolutions per minute. It is carried on a three-point suspension system, and has a nickel steel

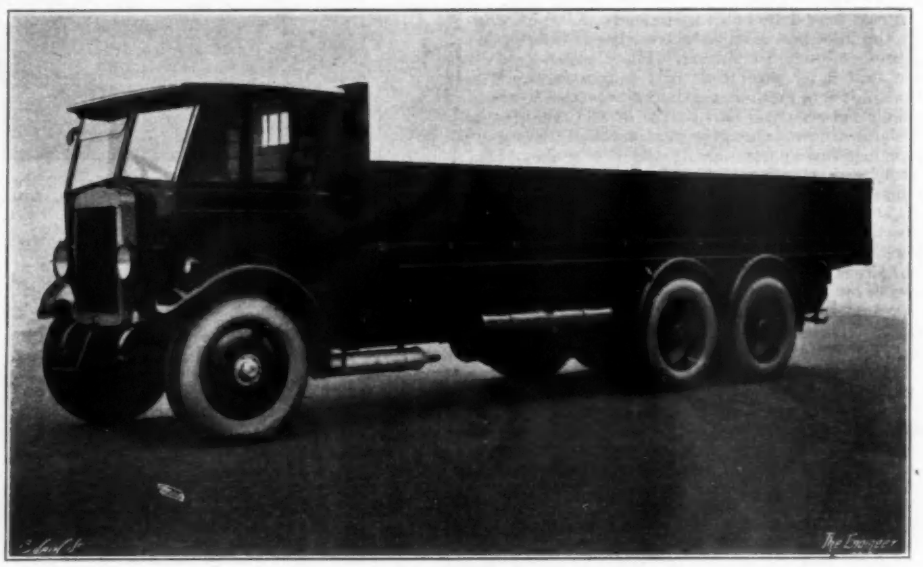


FIG. 23—10-12-TON SIX-WHEEL "HIPPO" LORRY—LEYLAND

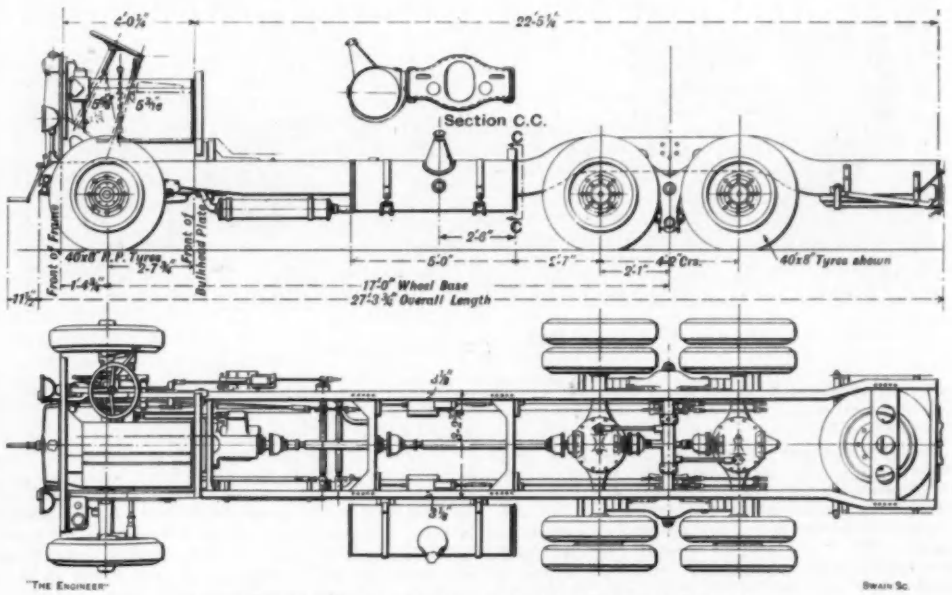


FIG. 24—ELEVATION AND PLAN OF "HIPPO" LORRY—LEYLAND

dynamically-balanced crank shaft with seven main bearings, 2¾in. diameter. Overhead valves and camshaft with accessible tappets and a quickly detachable head for grinding-in and decarbonising, centrifugally cast valve seatings and liners are fitted. Coil or battery ignition is used, the coil having automatic advance. The fan is driven by a chain through a damper clutch, thus avoiding belt trouble, and the water circulation is by means of a centrifugal pump. The clutch is a single-plate and the gear-box provides four forward speeds and reverse, the gears and shafts being ground all over. A new feature is the change speed gear control which is mounted direct on the engine, and is enclosed in an oil-tight case. The steering is of the Marles type, fitted with Timken combined thrust and journal bearings, the whole working in oil. Three tubular propeller shafts are used, with five Spicer mechanical couplings, and all couplings are easily accessible. Each rear axle casing is made from a one-piece nickel-steel forging with overhead worm drive, and is of the full-floating type with 2¾in. diameter axle shafts. The worm wheels are adjustable sideways. The axle ratio is 9·33 to 1. Torque rods with ball ends are fitted to transmit the driving and braking torque direct to the chassis frame.

A deep section frame, the maximum section being 12in. by 3¼in. by $\frac{7}{16}$in., is used. The height of the frame from ground, loaded, is 2ft. 7⅛in. The foot brake operates through three Dewandre-Servos to 17in. drums on all six wheels; the hand brake

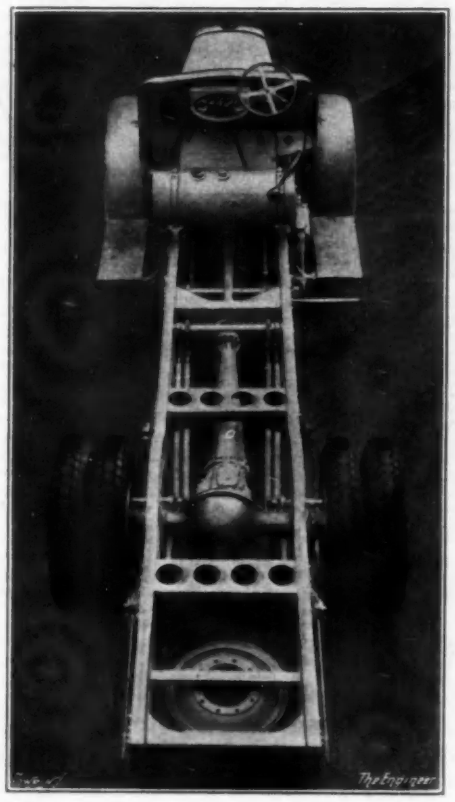


FIG. 25—4-TON PETROL CHASSIS—LEYLAND

operates on separate shoes in the same drums on the four bogie wheels only. All the shoes are interchangeable and are of the internal-expanding type. Fabric liners are fitted. The brakes are totally enclosed by dust covers and adjustment is provided by accessible wing nuts. Road springs of chrome-vanadium steel are used, and rubber buffers are mounted on the frame to take excessive shocks. All shackles are provided with adjustment to take up end play. The chassis lubrication is by grouped Tecalemit grease nipples in accessible positions.

The "Bison" chassis—Fig. 25—made by Leyland Motors, Ltd., is suitable for carrying a useful load of 4 tons and is propelled by a four-cylinder engine with cylinder dimensions, 4 $\frac{5}{16}$in. bore by 5½in. stroke. The R.A.C. rating is 33·3 and the brake horse-power at 1000 revolutions per minute is 50. Many of the features referred to in the larger chassis are embodied in this vehicle, including single-plate clutch, four-speed gear-box and Marles steering.

The transmission consists of a tubular cardan shaft supported by two Spicer mechanical couplings and tubular propeller shaft carried in a torque tube. The front end of the torque tube is anchored by a spherical joint to a frame cross member of heavy section. The axle casing is made from a one-piece nickel-steel forging. It is of the spiral-bevel type, with a double reduction by double-helical gears. The axle shafts are of 2½in. diameter and are fully floating. The hubs are mounted on Timken bearings and are easily detachable. The axle ratio is 6·6 to 1, with alternatives of 7·15 to 1 and 8·19 to 1.

The frame is of channel section, 9in. deep at the point of greatest stress and is designed with a "kick-up" over the rear axle; the dimensions of the side members are 3in. and $\frac{1}{16}$in. in thickness. Six pairs of very large interchangeable brake shoes are provided, four pairs in the rear wheels and two pairs in the front wheels. There are a foot brake operated through a "Dewandre-Servo" mechanism to all four wheels and a hand brake to separate shoes in the rear wheels. The brakes are entirely enclosed, and the adjustment is by single hand nuts.

THORNYCROFT.

The exhibits of John I. Thornycroft and Co., Ltd., on several stands indicated the wide range of four and six-wheeled vehicles which this company makes,

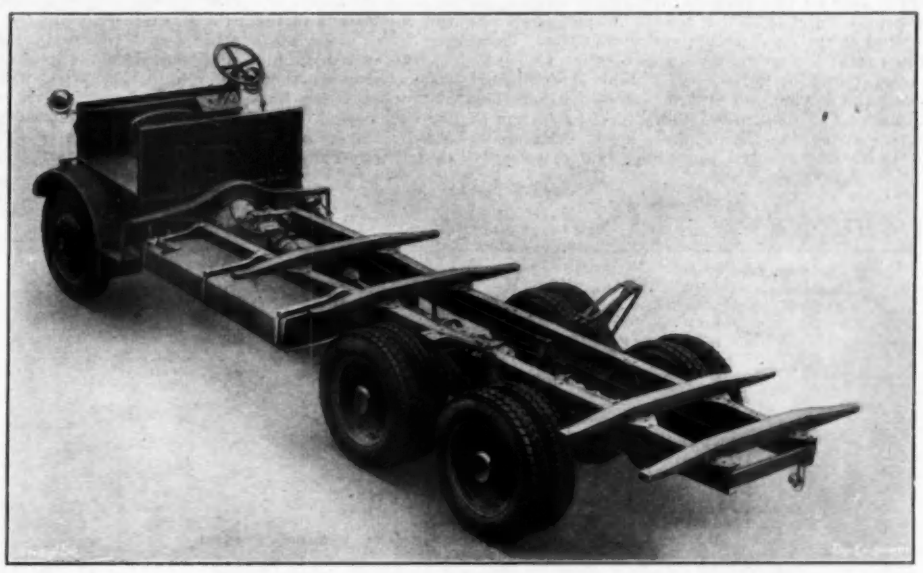


FIG. 26—10-TON SIX-WHEEL CHASSIS—THORNYCROFT

both for goods transport and for passenger carrying. The success of the makers' rigid six-wheeled chassis, with its patented system of rear axle suspension, has enabled the development of the rigid six-wheeled double-deck omnibus, one of which is shown for the first time. A 10-ton six-wheeled freight chassis is shown in Fig. 26, and a double-decker omnibus in Fig. 27. The engine has cylinders 111 mm. bore by 133 mm. stroke, and the capacity is 7760 c.cm. The R.A.C. rating is 45·9 horse-power, but the engine will develop up to 90 horse-power at higher engine speeds. The centrifugally-cast cylinder barrels are pressed into a single block, which forms the water jacket and carries the valves, and the cylinders are covered by two detachable heads. All the valves are on one side and are operated by a single cam shaft, which is driven from the rear end of the crank shaft where the torsional oscillation is very slight. The crank shaft is made of nickel chrome steel and is carried in seven white metal-lined bearings, the aluminium caps of which are secured by steel keeper plates on studs screwed into the top half of the crank case. A vibration damper is fitted to the crank shaft. There is a very efficient system of lubrication. The oil pump is driven by skew gearing from the cam shaft, and is immersed in the oil in the base chamber, a large filter being fitted on the suction side. The filtering surface is so arranged that any dirt or carbon falls freely to the bottom of the case, and does not, therefore, tend to choke the gauze. When the sump is removed, the pump, drive and filter can very easily be detached in one unit, since the unscrewing of a single nut will release them. From the pump, the oil is passed into a cylindrical filter chamber which, being in an easily accessible position on the outside of the crank case, can be quickly removed without either loss of oil or the necessity to drain the sump. The chamber contains two concentric cylindrical straining elements, the inner one being composed of fine mesh brass gauze, whilst the outer medium, through which the oil leaves the filter, consists of towelling held in place between the two perforated sheets of brass. Should the oil become too thick to penetrate them, however, as when starting up on a cold morning, the strainers are automatically relieved until the lubricant flows more freely. A certain amount of oil escapes, in the form of a spray, from the main and big end bearings, and serves to lubricate the cylinder walls, gudgeon pins, tappets, &c., while the overflow from the relief valve lubricates the cam shaft timing wheels, which, together with the magneto timing wheels, receive some oil thrown centrifugally from the cam shaft end bearings to the rims of the cam shaft wheels, whence it reaches the teeth of the timing gears through specially drilled holes. Before any of the oil can return to the pump, it must pass through a perforated metal diaphragm extending over the whole area of the base chamber.

FIG. 27—"DOUBLE SIX" 68-PASSENGER OMNIBUS—THORNYCROFT

Ignition is by high-tension magneto with automatic advance. The clutch is of the dry single-plate description, and the gear-box has four forward speeds and a reverse. At the rear end of the gear-box is an enclosed metallic universal coupling, transmitting the drive to an intermediate propeller tube which is supported near the rear end by a ball bearing of the combined thrust and journal type, flexibly attached to one of the frame cross members. A hollow propeller shaft connects this intermediate tube to

the worm shaft of the forward driving axle by means of enclosed metallic couplings, the one at the forward end being free to slide; the two axles are connected by a short telescopic shaft with similar couplings. Under normal loading conditions, the transmission line is approximately straight throughout.

The driving axles are two cast steel casings, with full-floating differential shafts driven by overtype worms with a reduction ratio of 10·67 to 1. For service in exceptionally hilly country an alternative reduction ratio of 12 to 1 can be provided.

The rear suspension has been designed to give even distribution of the weight on all four wheels and freedom from spring distortion. Four inverted semi-elliptic springs are pivoted at their centres to brackets rigidly attached to the frame, and are mounted at each end upon the driving axles. These springs form the only connection between the axles and the frame, the latter being suitably strengthened to take the driving and braking stresses, which they transmit. The suspension is designed to permit of 6in. difference in driving axle levels. Excessive movement is prevented by rubber buffers securely fixed above and below the axles. The springs and spring pins are completely enclosed, and are thus protected from dust and mud. The built-up brackets forming the connections between the springs and the chassis frame render dismantling and reassembling of the bogie units simple operations.

Grease gun lubrication is provided for all working parts of the chassis. The foot brake, which is assisted by a vacuum-servo cylinder, utilising the suction developed in the induction pipe of the engine, operates self-energising internal expanding shoes fitted within drums attached to the wheels of both driving axles. A cross shaft, which operates the cam levers on the driving axles, is situated in brackets between the latter, and is so placed that the lines of motion of the axles correspond to the movements of the ends of the brake rods, brake binding owing to the action of the springs consequently being eliminated. The hand brake, which is actuated by a lever at the right-hand side of the driver, is of the external contracting band type, acting on a wide drum fitted to the rear end of the intermediate propeller tube. All the stresses from this brake are taken directly by a stout channel-section cross member, which is well braced to the frame side members.

Magnetos.

In the accessories section of the Exhibition, the British Thomson-Houston Company showed, amongst other things, a new type of magneto—the "H.E."—for the first time. This instrument gives two sparks per revolution of its shaft, which carries a rotating magnet, while the windings and condenser are stationary. Recent advances in the design of heavy commercial vehicle engines demand the use of magnetos of the stationary armature kind, in which the high-tension current is led direct to the distributing electrode without the intervention of slip rings and collector brush mouldings. The "H.E." magneto includes this feature with the advantages of the polar inductor magneto. It also embodies a straight 25 per cent. nickel steel shaft, a laminated magnetic circuit and a jump spark distributor. Combined with the jump spark distributor is a roatry safety spark gap, the breakdown voltage of which is claimed to be more reliable than that of a stationary gap, because of the greatly minimised liability to ionisation. Another type of magneto and impulse starter also provides for varying the ignition by the partial rotation of the contact breaker cam on its bearing. The actual amount of variation is 24 deg. between advance and retard, but the cam can be moved slightly more than that in order to give the "off" position in which the blade projecting from the contact breaker cover makes contact with the pillar which holds the contact breaker cover in position. We have referred previously to the combined magneto coil ignition sets made by this firm.

Vacuum Brakes and Door Equipment.

Pneumatic braking for motor vehicles and especially of motor buses, is making headway. G. D. Peters and Co., Ltd., Slough, showed a model of a vacuum system for operating both the brakes and the doors of omnibuses, which appears to satisfy the requirements in both cases. A demonstration omnibus was run in connection with the Exhibition on which the above-mentioned equipment was provided. For the vacuum-operated door control a small amount of current, such as is obtainable from a 12-volt lighting battery, is also used to energise the electro-vacuum valves that control the system, but no current is required except when the vehicle is at rest with the doors open. Provision is made for interlocking the door equipment both with the vacuum-operated brake and the hand brake on the vehicle, so that in cases of emergency, the doors cannot be opened until the omnibus is at rest with the brakes applied. The control of the doors is then in the hands of the driver and conductor when the omnibus is in use as a "two-men" unit, or of the driver alone when in use as a "one-man" unit. The necessary vacuum is obtained from a reservoir connected with the engine induction pipe, which also operates the brakes. The brake cylinders, one for each wheel, are of the rubber diaphragm type, fitted with an anti-buckling device which prolongs their life. They are very simple in construction.

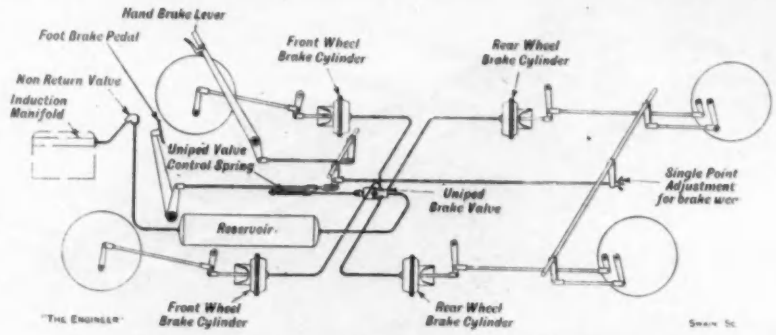


FIG. 28—DIAGRAM OF VACUUM BRAKE SYSTEM—PETERS

The method of applying the vacuum brake resembles the method employed in manual braking. The reservoir is connected by a copper pipe to a driver's valve, which is operated by a foot pedal or lever. This controls the creation of vacuum in the brake cylinders, which are placed as near as convenient to the brake drums without the need for complicated brake rigging. To release the brakes the induction pipe is isolated from the brake cylinders, and the vacuum in them is destroyed by the admission of air from the atmosphere. A diagram of the brake system is given in Fig. 28. The total weight of the full omnibus equipment is stated to be about 90 lb.

SIXTY YEARS AGO.

A THREE-LINE paragraph in our issue of November 19th, 1869, announced that "a scheme for a Canadian Pacific Railway appears in the newspapers of the Dominion; the length of the line is 2500 miles and the capital £20,000,000." We and probably even at that time Donald Alexander Smith—later to become Lord Strathcona and Mount Royal—could scarcely have foreseen the vast developments which were to take place in the scheme thus modestly announced. From Canada we may turn in the same issue to an article translated from the *Russian Railway Gazette*, in which a remarkable picture was drawn of the conditions attending railway construction in the empire of the Czars in those days. Although railway construction was begun at a relatively late period in Russia, little profit was, it seems, derived from a study of the mistakes made by the railway pioneers in other countries. Indeed, according to our Russian authority, many of the worst faults committed elsewhere were not only copied, but actually exaggerated. The trouble arose from the fact that those who obtained a Government concession for the construction of a railway in Russia, those who actually built it, and those who finally managed it were rarely one and the same body of persons. It was alleged that the concessionnaires having obtained from the Government as much as £13,000 per mile for the construction of some proposed railway, would purchase all the machinery required, and place the necessary contracts for carrying out the work, and that the total cost to them might be only £10,000 or less per mile. Having secured £3000 or more per mile in this manner, they considered that their obligation had been fulfilled, and faded from the scene. The management was then formed to take over and operate the line, but it had to accept things as it found them, for it had no power to alter accomplished facts. Not infrequently the working of this system resulted in the districts and towns intended to be served by the railway being placed at considerable disadvantage, because of spite on the part of the constructors or because the inhabitants had displeased them by asking more than they were prepared to give for the land required for the stations, &c. A case typical of many was mentioned in the article. In order to punish the inhabitants of a certain town who had sought to secure more for their land than the constructors wished to pay, the station designed to serve the town was erected 8 miles away in an open field. The inconvenience caused by the excessive distance frequently existing between the stations and the towns they were intended to serve severely restricted the benefits which the populace was entitled to expect from the railways. The transport of passengers and goods to and from the stations became centred in the hands of a legion of agents, whose removal, it is to be inferred, was earnestly desired. There were those who longed for the return of the old-time road carrier, who not only conveyed his passengers from door to door, but studied their comfort *en route*. At that date, it seems, Russian railway carriages were equipped with unpleasantly narrow seats, were defective in their ventilation, and even in winter were entirely unprovided with heating means. Sleeping cars were looked upon as an unpardonable luxury and indulgence.

B.E.S.A. Specifications.

SPECIFICATIONS FOR COLLIERY REQUISITES.

In continuance of the programme of work in its Colliery Section, the British Engineering Standards Association has just issued "British Standard Specifications for Underground Lighting Fittings" and for "Flattened Strand Winding and Haulage Wire Ropes." The Underground Lighting Fittings Specification provides for fittings for use with British Standard vacuum tungsten filament lamps, with a minimum rating of 60 watts, and its main purpose is to ensure interchangeability of such parts as well as glasses that require frequent replacement. The provisions in regard to interchangeability are also extended to cover the attachment of the cables so that with the new standard fittings quick replacement of damaged fittings will be facilitated.

The Flattened Strand Rope Specifications, following the lines of the Round Strand Colliery Rope Specifications, contain clauses regulating the testing carried out in connection with the purchase of colliery haulage and winding ropes, tensile and torsion tests of the wire being specified both before and after the manufacture of the rope. After the issue of the round strand rope specifications, it was felt desirable, in view of the large use of flattened strand ropes, mainly in South Wales and Lancashire, but to a certain extent in the other coalfields, to consider the preparation of flattened strand rope specifications. Examination showed that, although there was a large variety of constructions recommended for specific purposes, there were several constructions common to makers of flattened strand ropes not only in this country, but in the United States and on the Continent. The difficulty in the way of the preparation of specifications lay in the fact that no agreement had been reached amongst manufacturers as to breaking strengths and weights. Standard tables have now been agreed with the makers, and these are included in the Specifications.

STEEL BALLS FOR BRINELL TESTS.

The British Engineering Standards Association has just published a standard specification for the Hardness of Steel Balls for Brinell Hardness Testing, Part II. of B.S. Specification No. 240. This specification forms the supplement to the report on Brinell Hardness Numbers which was issued in 1926, and in which a note was added indicating that a specification for the hardness of the balls would be prepared. The information embodied in the specification is based upon the results of research carried out at the National Physical Laboratory. Recommendations as to the hardness of the balls to be used in testing materials of varying hardness are made, and tables are given from which the hardness of balls can be determined by means of the diamond indentation test, and reciprocal pressure test.

Copies of these Specifications can be obtained from the British Engineering Standards Specification Publications Department, 28, Victoria-street, London, S.W. 1, price 2s. 2d. *each*, post free.

The Rushton Agricultural and Roadless Tractors.

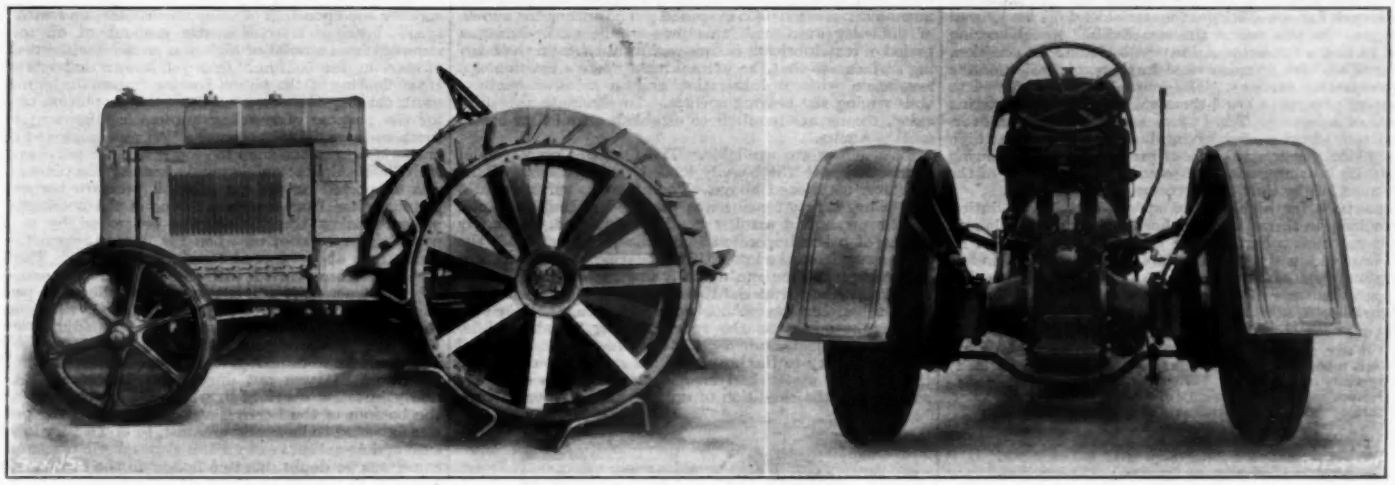
In view of the world marketing scheme for British agricultural machinery referred to in to-day's Seven Day Journal, and the statements of Mr. G. E. Rowland, the chairman of Agricultural and General Engineers, Ltd., and Mr. George Rushton regarding the manufacture and sale of the Rushton tractor, it will interest our readers to have a brief description of the agricultural and roadless models which we have inspected under construction at the firm's Walthamstow works.

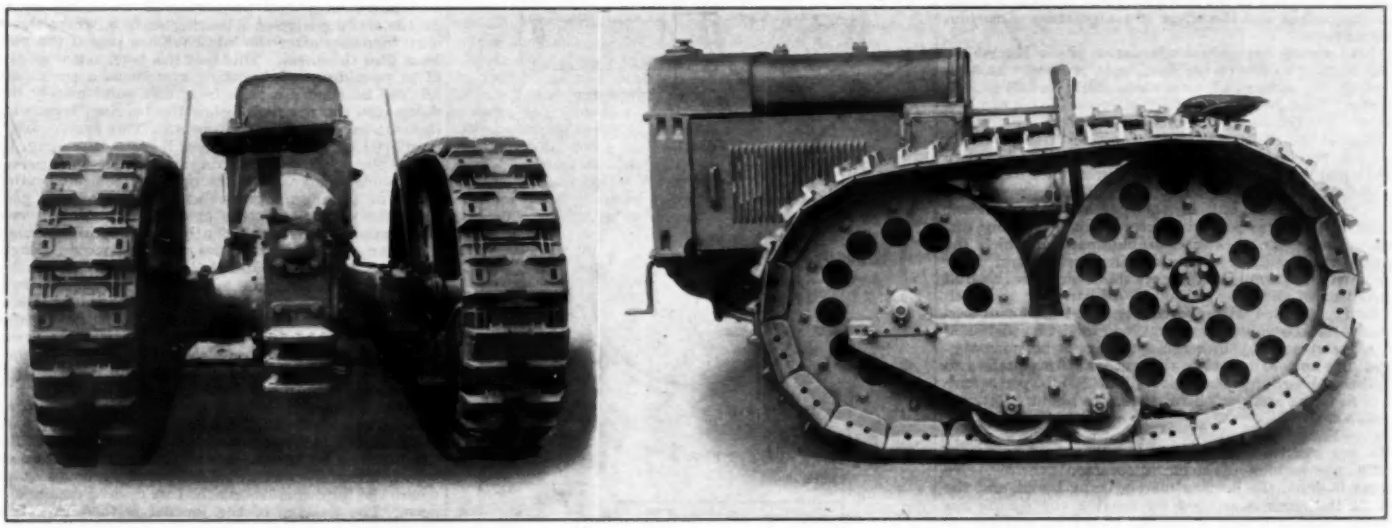
It may be remembered that the Rushton tractor was taken up by the Associated Equipment Company, Ltd., of Southall, about a year and a-half ago, and five hundred tractors were built. As a result of the success achieved, a new company was formed, and about five weeks ago a new plant was completed at Walthamstow, at the old A.E.C. works. Actual manufacturing operations were begun some three weeks later, material having been ordered for 5000 tractors. It is confidently believed that by Christmas the output will have risen to fifty tractors per week, and the ultimate estimated capacity of the factory is 30,000 tractors a year.

As our illustrations show, there are two principal models, one for agricultural work and the other of the roadless type, with an endless chain track. The power unit is the same for both models, and comprises a four-cylinder, 14 to 28 H.P. engine running at 1200 r.p.m., with cylinders of 4½in. bore and 5in. stroke. The engine is designed to run either on petrol, paraffin, or light fuel oils. Accessibility has been closely studied. The cylinder head is detachable and the crank case can be removed to enable the main bearings to be inspected without stripping the tractor. The lubrication of the engine is effected by a circulating splash system, with the addition of special oil feeds to important parts. The engine is cooled by a thermo-syphon system, incorporating a water impeller and a fan-cooled radiator. The combustion air is drawn through a special automatic water cleaner. Ignition is effected by a high-tension magneto fitted with an impulse starter and the carburetter is of the standard Solex type, with a specially designed vaporiser for the heavier fuels.

The transmission is of the usual three forward speeds and a single reverse type, which can be supplemented when desired with an auxiliary three-speed gear-box, operated through a hollow worm gear with a return drive to the main transmission, providing six forward speeds. With the standard gear-box the three forward speeds are

THE RUSHTON AGRICULTURAL TRACTOR





1¾, 2¾, and 4½ miles per hour for the bottom, intermediate and top gears respectively. A 21-plate metal-to-metal clutch running in oil is provided.

An interesting feature of the agricultural model is the front axle and suspension, which is so arranged that a very short wheel base can be obtained when required. The principal dimensions of this model are as follows:—Short wheel base, 4ft. 4in.; long wheel base, 6ft.; the overall length of the tractor is 9ft. 8in., with a width of 5ft. 2½in.; height, 5ft. 1in.; and a ground clearance of 1ft.; the drawbar pull in the top gear is 4500 lb., and 2800 lb. in intermediate gear; the unladen weight of the machine is about 35 cwt.; and the ploughing speed is 2¾ miles per hour. As will be seen from the upper engravings, the rear wheels are of rolled steel with steel spokes cast in the hub. The rims are 46in. in diameter and 12in. wide, and special detachable cleats are bolted to the rims. A neat form of wheel scraper is also provided. The front wheels are of cast steel, have a diameter of 27in., and are mounted on roller bearings. For easy steering in soft ground, detachable rim flanges can be fitted.

The driver's seat is adjustable and is arranged in a convenient position, and the steering gear, which is of the worm and sector type, is furnished with a raked column and wheel, to which the throttle controls are attached. Below and forward of the driver's position is a pulley, so arranged that a belt drive is obtained free from all obstructions. The draw bar bracket is clearly shown in the upper right-hand engraving; it provides for the vertical and lateral adjustment of the hitch, alternatively an underslung draw bar can be fitted. As shown in one illustration, pneumatic tires, with mud guards, can be supplied, if desired. A transmission brake is fitted.

The two lower engravings illustrate the roadless model, which is fitted with an unusual design of endless track. The arrangement is one which does away with the pin joint, all necessary movement between the plates being provided for by blocks made of a particular quality of compressed rubber. The exhaustive experiments which have been carried out during the last eighteen months with this track have demonstrated its general efficiency. The sprockets are made from steel pressings and the teeth are formed by steel rollers working on hardened steel bushes. The idlers are also made of pressed steel. A particular feature of the roadless model is the weight distribution, which has been so arranged by throwing the weight well forward that any danger of the tractor turning over backwards, owing to the torque reaction at the sprocket, is avoided. All parts of the endless track equipment are interchangeable, so that they can be quickly fitted to any existing wheeled model.

The principal particulars of the roadless model are as follows:—Unladen weight, 2 tons 10 cwt.; overall length, 9ft. 3in.; width, 5ft. 4in.; height, 4ft. 11in.; the drawbar pull in top gear is 5100 lb., and that in intermediate gear 3100 lb. Two fuel tanks, one of 18 gallons and one of 1 gallon are provided, and the fuel consumption for both the models we have described is about 1½ gallon of paraffin or petrol per hour at the normal working speed.

Journal Bearing Practice.*

By FRANCIS HODGKINSON, of Philadelphia, U.S.A.

It is proposed to consider principally the problems of bearings for such machines as dynamos, motors, steam turbines, and the like, where flooded lubrication is applied and the machinery must be placed in operation with the full unit load on the bearing.

It may be surmised that a journal revolving in a bearing was the earliest piece of mechanism devised by mankind. Certainly it is to-day the most common component of machinery of all kinds, yet it would seem that this mechanism, simple though it is, is not generally understood, although many engineers, such as Beauchamp Tower, Osborne Reynolds, Sir John Dewrance, A. Summerfeld, A. G. M. Mitchell, and Albert Kingsbury, have done much to advance our knowledge of bearing design. One still hears of that archaic expression, PV, as a measure of the duty of a bearing. It has had various modifications, some engineers believing that the form $P\sqrt{V}$ is nearer the truth.

It would seem that there is no practical use for any such formula, but if there must be one, it should, for any one type of design of bearing, and one kind of lubricant, take the form $P(V^{-x})$, for surely with the ordinary bearing supplied with lubricant at the point of least pressure, the higher the velocity the greater the unit pressure which may be borne. The author makes no attempt to assign any numerical value for the negative exponent of V. Even with this formula, we would be presented with an anomaly should a high-speed bearing with zero load be considered; that is, a shaft passing through a shell with clearance all around it and containing lubricant. At a high velocity the energy expended would not be much less than with reasonable unit pressure on the bearing.

An important factor of modern bearing design is knowledge of the centrifugal action of the lubricant when it is squeezed between the surfaces—that is to say, the fan-like path of the oil particles when subjected to pressure, and the relative motion of the surfaces. Here there would seem to be room for research, but even without it, the author has no hesitation in affirming that the bearing loads which are common practice to-day may be much increased, with a slight gain in overall efficiency of the machinery and in many cases a substantial shortening of generator sets, &c.

The limit of velocity of a journal is not known. Inasmuch, however, as the losses vary theoretically as V^2, perhaps as $V^{3/2}$ for the higher velocities, they will increase at such a rate that a practical limit will be set by permissible loss rather than by failure of the lubricant.

At this point, the action of a lubricant might be referred to since some old books would have us believe that particles of lubricant form themselves into little rollers and revolve like those of a roller bearing. This is, of course, fallacious. A particle of oil will adhere to both stationary and moving surfaces, and the motion of the parts will shear this particle. It is the area of shear, the viscosity of the lubricant, and the rate of shear—which varies with the thickness of the film—which make up the bearing loss. An apt definition of a good lubricant is: "The best lubricant is that fluid which possesses the greatest degree of adhesion and the least degree of cohesion."

The amount of lubricant supplied for purely lubrication purposes is much less than that supplied in regular practice. For high-speed bearings, many times the needed quantity of lubricant is supplied for the purpose of carrying away heat, and it is every-day practice to provide apertures for the outlet of oil at the ends of bearings, or to provide clearances to increase the flow.

Since the loss in a flooded bearing is purely the result of fluid shear, it would seem that coefficients of friction, as ordinarily understood, have no place in the consideration of bearings. Whilst this may be true, for comparative purposes it is convenient to express a bearing loss in the term of an equivalent coefficient of friction. It would further seem that inasmuch as the journal is entirely borne on an oil film, and there is no metallic contact, the character of the metals of the respective rubbing surfaces is not important, provided they have the requisite truth, rigidity, strength, &c. This is true, but provision is usually made that there shall be the least destructive effect in the event of an interruption of the oil film. Hence, the introduction of white metal linings of various kinds.

The lining of a bearing, however, with a metal of suitable character, has yet another purpose than that of merely protecting the journal from injury in case of accident, for, with well-designed lubricating systems, there is little excuse for an interruption of the oil film. Compressive elasticity seems to call for a definite minimum thickness of the bearing lining in accordance with the conditions. In cases of heavy bending moments the axis of the journal assumes a readily calculable curve. Journals are seldom true cylinders. Sometimes, due to a bent shaft, the ends of the journal assume an oppositely-disposed excentric path—wobble. In addition, the bearing surface itself is imperfect. For these reasons, a bearing surface that is inelastic would be inappropriate.

In calculations of this kind in the United States of America, it has been customary to assume the following moduli of compressive elasticity:—

	Pounds per sq. in.
Tin-base metal—	
Moulded in chilled form	2,000,000
Slow-cooling	1,000,000
Lead-base metal—	
Moulded in chilled form	900,000 to 1,000,000
Slow-cooling	400,000 to 700,000

An instance may be cited of successful bearings for a large stabiliser for a ship, whose rotor weighed 230,000 lb. running at 800 r.p.m., with the design of which Mr. Alexander Schein, of the Sperry Company, was closely identified. The journals were 18½in. diameter by 28in. long, and the limits of truth and roundness, collectively, were required to be within 0·0002in. The calculated deflection of the journal was also about 0·0002in. The maximum bearing pressures approximated to 900 lb. per square

* The Institution of Mechanical Engineers, November 15th.

inch of projected area at the usual rate of precession, with an average pressure of 720 lb. per square inch, and it is true that the shaft pressures were reversed to the opposite wall of the bearing at each precession and the stabiliser could reach full speed without material load on the journal bearings. In this case a tin-base Babbitt metal bearing liner, having a thickness of $\frac{1}{8}$in. was selected. In addition, the greatest care was exercised in the preparation of the two respective surfaces. The journals were subjected to a lapping process to bring them within the above exacting degree of accuracy. Tests were carried out with an over-speed rate of precession, giving bearing pressures as high as 1200 lb. per square inch of projected area, following which the bearing surfaces showed only burnishing of the high spots left by the fitting process.

Sometimes for high surface speeds and heavy duties, particularly in thrust bearing shoes for axially unbalanced steam turbines, a hard copper is employed because of its high heat conductivity. An extreme example of this is a Kingsbury type of thrust bearing which has been in successful operation for two and a half years. With full load on the turbine, it sustains a load of 181,000 lb. It has the following characteristics :—

Net area of shoes	347 sq. inches
Unit pressure referred to net area ..	522 lb. per sq. inch
Speed	1800 r.p.m.
Surface speed at outer radius of shoes	198ft. per second
Surface speed at inner radius of shoes	80·4ft. per second
Viscosity of oil at 100 deg. Fah. (approx.)..	250 sec. Saybolt
Temperature of oil ingoing (approx.)	100 deg. Fah.
Temperature of oil outgoing (approx.)	120 deg. Fah.

In this instance, there was some elaboration of design in the pivotal supports of the shoes to reduce deflection in the shoes themselves and the effect of temperature distortion of the surfaces.

In 1911 during the earliest adaptation of the Kingsbury thrust bearing to steam turbines, unit pressures as high as 7000 lb. per square inch were successfully carried experimentally. Unit pressures slightly in excess of this resulted in failure, not because of the breaking down of the oil film, but because the resistance to compression of the Babbitt metal was reached, and it became "mushroomed" more or less equally with and against the direction of motion.

It should be stated that this thrust bearing was fitted with ten segments, but in the particular experiment referred to, all were removed except two oppositely disposed. There was, therefore, ample space in which the lubricant could adhere to the moving surface and carry away heat. One would not expect this bearing with a full complement of shoes to be capable of carrying any such unit load. Perhaps with the conventional design of segmental thrust bearings more total load might be sustained with reduced area by increasing the space between segments. In normal practice, the author's firm prefers to limit thrust bearing pressures to about 300 lb. per square inch of net area and peripheral speeds to about 125ft. per second.

For ordinary journal bearings with pressures up to 150 lb. per square inch of projected area, a clearance of 0·002in. per inch of diameter is common practice. No scraping is done, the bearing merely being bored, and the relief at the sides is secured by moving the boring bar sideways, leaving 90 deg. to 100 deg. of bearing surface—as shown in Fig. 1. The bores forming the relief at the side are not generally carried through, but with higher journal velocities openings are provided at these points for the purpose of increasing flow in order to carry away heat.

Bearings prepared and machined with no more precautions than described are capable of carrying loads up to at least 175 lb. per square inch projected area with velocities not less than 20ft. per second, and except for failure of lubrication, will run indefinitely without wear. In the author's practice, journals for such bearings are required to be within 0·0005in. of roundness and truth. Accuracy in this respect is conducive to easy balancing and smooth running.

Much higher loads, once the bearing is in operation, may be carried by giving consideration to the actual bearing surface, that is, by scraping it accurately to a mandrel a specific amount larger than the journal with which it will operate, still maintaining the 0·002in. overall clearance per inch of diameter mentioned. In other words, this is done by providing an original bore, with side relief, which, when the lower bearing surface is scraped to a mandrel, say, 0·00025in. per inch of diameter greater than the journal, will give an approximate clearance between the journal and the top of the bearing of 0·002in. per inch of diameter. This is the construction used in the gyroscope bearings mentioned when pressures at least in excess of 400 lb. or 500 lb. per square inch of projected area may be carried, provided the bearing is once in successful operation. Loads even in excess of this may be carried by increasing the actual area by the use of pivoted bearing pads after the manner which, in Great Britain, is known as the Michell bearing, and in the United States as the Kingsbury bearing, illustrated in Fig. 2. This is a means of increasing the effective bearing area without sacrifice of unit pressure on the area. The limit of pressure for such a bearing, per square inch of projected area, may well be of the order of thousands of pounds, and it is capable of operation at lower velocities than bearings of the more common type discussed previously.

This type of bearing with pads capable of being tilted is doubtless able to sustain higher loads than any other known construction, and should be entirely satisfactory in operation, provided the combination of weight and forces on the revolving part is always in one direction. Should there be reversal of load, and if the journal requires bearing surface around its whole circumference, a difficulty arises which might be crudely described by saying that expansion, the result of rise of temperature, takes place more from the outside inwards, as compared with ordinary bearing constructions, and this effect may in some cases result in loss of clearance if not foreseen.

With such high bearing duties the oil film, while complete and sufficient, may be so thin that small particles of grit in the lubricant may cause wear. Greater care must therefore be exercised in keeping the lubricant clean. The large quantities of dirt and grit that may be circulated without injury through the ordinary steam-turbine oiling system could, of course, not be tolerated.

The importance of tight Babbitt metal is emphasised. If there are any air pockets between the Babbitt metal and the shell those regions will be depressed by the film pressure, and the bearing pressures will be concentrated elsewhere.

Pressures with ordinary journal bearings supporting rotor weights in excess of 175 lb. per square inch projected area have not often been exceeded. The author has known of difficulty even with this pressure because, during a period of rest, lubricant is squeezed from between the bearing surfaces, so that the journal must make a fraction of a revolution without lubrication and in metallic contact, thus wiping the bearing surface. To eliminate this difficulty, means are required to establish an oil film before motion occurs.

Two means are available. The first was employed in connection with the heavily loaded thrust bearing of the stabiliser mentioned above. The axis was vertical and a Kingsbury thrust bearing was provided at the lower end. At the upper end a roller bearing was fitted, which, by means of a hand-operated hydraulic jack, could lift the rotor away from the lower thrust bearing a small amount. The rotor was then run up to a small fraction of normal speed and lowered to the Kingsbury bearing, in which an oil film had become established. With the stabiliser continuing in operation the roller bearing remained idle. The prime object, however, of doing this was not so much to avoid injury to the bearing when starting, but because the spinning motor had insufficient torque to start the rotor under the condition of unlubricated friction at rest.

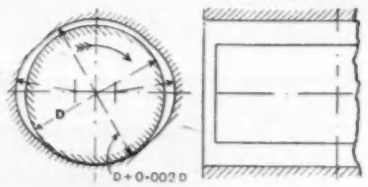


FIG. 1

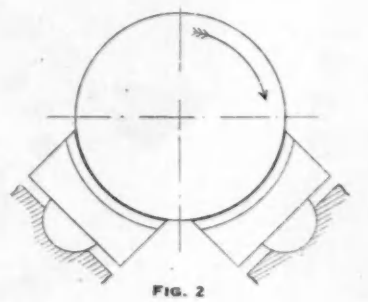


FIG. 2

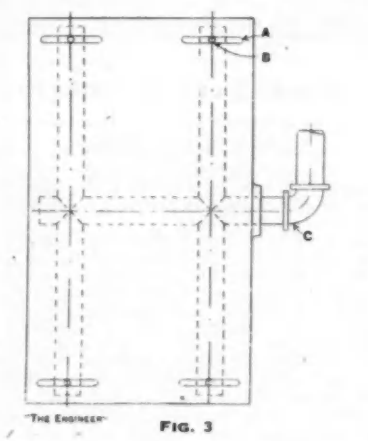


FIG. 3

This method would seem inconvenient for horizontal shafts.

The second method applies to both horizontal and vertical shafts. It provides properly disposed grooves at the corners of the bearing surfaces, into which high-pressure oil may be pumped to separate the surfaces and establish the film. As soon as a small speed is attained, the supply of high-pressure oil may be discontinued. This method was employed in the case of some pivoted journal bearing pads for a balancing machine. Any such grooves in bearing surfaces for the purpose of separating the surfaces by means of oil pressure are quite indeterminate in their effective area, because of the character of the adjacent surfaces, so the mere admission of oil of sufficient pressure may have the effect of separating one corner only and concentrating the pressure on an opposite corner.

The plan adopted was to provide a bearing pad—Fig. 3—with a groove A at each corner, oil being admitted to the corners through an orifice B of definite size. A source of oil C was selected, at a pressure considerably in excess of that required to separate the surfaces, so that the orifices became metering devices to supply nearly an equal flow from each groove between the surfaces, thus definitely separating all corners of the surface by some small amount. With this construction, bearing pressures of more than 600 lb. per square inch are regularly carried at speeds of the order of one-tenth of the normal running speed of the turbine rotor.

Many experimenters have determined oil film pressures and thicknesses in different zones of the bearing, and, with different loads, speeds, and viscosities, the angular position of the journal in the bearing. A valuable paper on this subject was recently read by Professor Goodman.* To secure consistent results from film pressure measurements would require considerable accuracy of the surfaces, because unevenness in the bearing surface would give extreme differences of pressure in adjacent zones where it would be expected that the pressures would be alike.

Oil from a bearing has often been supplied under pressure for the operation of some mechanism, and with high-speed bearings a considerable amount of oil may be removed from a point of high film pressure without danger of starving the bearing. One well-known example of this is the floating of the pinion bearing frames for high-power tooth gearing, such as is used for the propulsion of ships, for the purpose of securing automatic alignment of the tooth surfaces. Such a construction was employed by the author's firm at one time to accomplish the purpose of the Melville-McAlpine flexible pinion frame. The pinion frame was supported on pistons with oil pressure beneath the pistons taken from a pressure zone of the bearings. The pressure below the pistons was controlled by a valve, permitting escape of oil when the pistons supporting the frame rose above a predetermined elevation. The pressure, therefore, varied with the tooth reactions. With this construction it was customary to calibrate a pressure gauge with readings of power developed, which served thereafter as an accurate power transmission dynamometer. With the pressures once calibrated, reliable power readings could be obtained as long as the bearing was in good condition. It was not uncommon, however, that with newly installed bearings in which the oil was taken from the bottom of the bearing at a point where the pressure was expected to be nearly greatest, to find a very low pressure and sometimes even a sub-atmospheric pressure. The cause was no doubt due to a hollow in the bearing surface adjacent to the orifice and was easily remedied by a little scraping.

A sub-atmospheric pressure will invariably be found on the trailing edge of a bearing surface, where the clearance increases after the lubricant has passed the point of least film thickness. This fact has been taken advantage of in providing a lubricating system as a substitute for oil ring bearings; a tube from this point merely reaches down into the reservoir below the bearing, from which it draws a supply of new lubricant. This system has been employed on shipboard, where, because of rolling, it was feared the operation of oil rings might not be satisfactory.

It is customary, with the ordinary journal bearing, to admit oil to an axial groove at the point of least pressure or to the clearance spaces at the sides. This is entirely satisfactory with a sufficiently large ratio of length to diameter and where velocities are high enough. Engineers in the past have considered that good practice with such bearings demanded some minimum ratio of length to diameter. This was not without good reason, particularly with slow-speed bearings. It was again the question of the direction of flow of the oil particles between the surfaces. With more complete knowledge of the subject, it would seem there is no limit to the shortness of the bearing consistent with safe loading, pressures, &c.

In such cases, if the rate of thinning of the film with a given surface velocity, the load, the viscosity, and the result of the axial component of the direction of flow of the particles be known, one may, in extreme cases of low speed, introduce additional oil supply grooves at points where the lubricant has reached its desired degree of thinness. The passage of the journal is then over a series of bearing pads, and if these are arranged to be flexible or pivoted so much the better, and we have the Michell or Kingsbury bearing. Oil grooves of any kind, however, connected to the source of oil supply in the pressure zone of a cylindrical bearing as distinct from a bearing comprising tiltable pads are to be avoided if possible. Since they merely short-circuit the film pressure to that of the source of supply, not only is the film pressure lost in the area occupied by the grooves themselves, but it is lowered in the areas of the adjacent trailing edges. These are, of course, oil supply grooves formed in an axial direction. Circumferential grooves sometimes found in crank shaft and crank pin bearings of reciprocating machines provided with forced lubrication would seem to impair the value of a bearing to a still greater degree, as will be shown later.

Some important work on the subject of the path of the particles between the surfaces has been carried out by Mr. H. A. S. Howarth, of Philadelphia. In it, a large number of curves have been plotted by means of which film thicknesses and losses may be precisely determined. As, however, they have been based principally on hydrodynamic theory, the conclusions may not be completely realised in practice. Nevertheless, the subject-matter is of great value.

It would seem that with high-speed bearings there is no half-way ground between success and failure. They are all right or all wrong, and the point of increase of load or of speed reduction at which failure will occur because of the breakdown of the film may vary tremendously with microscopic differences of the surfaces.

In connection with the direction of the path of the particles in the film, or the distance which the film may be carried in a bearing, an interesting experiment was lately carried out on one of a line of large turbines. In order to facilitate quick starting of the partially cooled machines, it was decided to equip them with motor-driven turning gears so that the rotors could be maintained in slow motion during the periods they were out of action, thus preventing distortion of the rotors and to a great extent of the turbine stators due to unequal cooling or heating. The problem was to determine the lowest speed at which the oil films could be maintained. The experiment was carried out by permitting the turbine to come to rest under its own momentum. The point of breakdown of the film was easily discernible by a sudden change of the rate of retardation. Extreme accuracy of instantaneous speed measurements was necessary and was obtained by means of a fifty-segment commutator fitted to the rotor to give 100 impulses per revolution to an oscillograph element. Another element in the oscillograph recorded a 60-cycle wave. The speed of the photographic film was approximately 1in. per second.

Fig. 4 shows the revolutions per minute and the rate of retardation in revolutions per minute per second, plotted against time. Fig. 5 shows the rate of retardation in revolutions per minute per second, plotted against the speed of the turbine, in which the breakdown of the film is evidently shown to take place at about 18 r.p.m. A speed of 25 r.p.m. was selected as a minimum safe speed for the turning gear.

* "Proc.," Inst. C.E., 1928, Vol. 226.

The following data are added so that further deductions may be made :—

	Turbine.		Generator.		Exciter
Bearing number ..	1	2	3	4	5
diameter, in.	14	16	14	14	3
length, in. ..	24	24	24	24	8
Surface velocity at normal speed at 1800 r.p.m., ft. per sec.	110	126	110	110	
Bearing reaction, lb...	47,700	71,000	53,700	51,700	800
Unit load per sq. in. of projected area of journal, lb. per sq. in.	142	185	160	154	
Projected area of actual bearing surface, 120° arc, sq. in.	291	332·6	291	291	
Unit load per sq. in. of projected actual bearing area, lb. per sq. in.	163	214	185	178	
Surface velocity at speed where film broke down (18 r.p.m.), ft. per sec...	1·0	1·26	1·0	1·0	

Weight Moments.

	Weight, lb.	(Radius of gyration)², ft.²	Weight moment of inertia, lb. × ft.²
Turbine rotor ..	115,000	3·125	360,000
Coupling	7,400	0·803	5,950
Generator rotor ..	101,000	2·24	226,200
Exciter	1,570	0·223	350
Totals	224,970	2·643	592,500

Oil.

Viscosity at 80 deg. Fah., approx. ..	311 sec., Saybolt
Viscosity at 100 deg. Fah., approx.	195 sec., Saybolt
Viscosity at 140 deg. Fah., approx.	79 sec., Saybolt

NOTE.—The oil had been in service over a long period, which accounts for the viscosity being higher than in normal practice.

The equivalent coefficient of friction is least just before the breakdown of the film, as has also been shown by Stribeck and published by Dr. Stodola. It amounts in this instance to 0·00087 and 0·00117 for warm and cool oil respectively, at between 20 and 30 r.p.m.

Oil is by no means the only available lubricant. Air has sufficient viscosity to form a complete film between the surfaces, and even hydrogen has been employed in a demonstration. The film of air is thinner than with a liquid lubricant, and there must therefore be more perfection of the respective surfaces.

A series of experiments with an air lubricated bearing was carried out by Mr. Albert Kingabury. He pointed out that at that time air as a lubricant was by no means a novelty, and that in 1855 Hirn stated that "air under certain circumstances and in sufficient quantities becomes the best lubricator, the coefficient then falling to 0·0001."

The author once constructed a small thrust bearing which depended entirely upon air as a lubricant. Loads approximating 20 lb. per square inch—not measured—were easily enough sustained. The bearing was entirely satisfactory as long as the surfaces were clean, but it would fail with any accumulation of dust. Models both of journal and thrust bearings lubricated by air have been constructed for demonstration purposes at various times. The complete establishment of the air film may be shown by means of the electrical resistance of the air gap.

It may be that research into relative film pressure and thickness can be carried out with more exactitude by means of a gaseous rather than a liquid lubricant. Mr. Kingsbury's experiments were carried out by means of a solid plug, 6in. in diameter, revolving in a hollow cylinder, the load of the bearing being the weight on the plug. By revolving the outer cylinder the gauge holes could be placed in any angular position. In Fig. 6 a polar diagram is reproduced of the pressure curve observed at the centre of the bearing at two speeds, 230 and 1730 r.p.m., and the point of maximum pressure and minimum film thickness is indicated at the two speeds. It will be noted that the pressure distribution varies with the speed and that the point of maximum pressure is 30 deg. to 44 deg. behind the point of minimum film thickness. Sub-atmospheric pressure will be observed in the upper zone of the bearing. Fig. 7 shows the angular position of maximum pressure and minimum thickness of the film, and hence the angular relation between the two.

From Mr. Kingsbury's data, Fig. 8 has been plotted. Curve A shows the pressures measured along the axis of the bearing at about the regions of maximum pressure and at 230 r.p.m., illustrating how the film pressure falls because of its flow to the ends of the bearing. Similar curves are shown by Dr. Stodola culled from a variety of sources. The pressure distribution in an axial direction bears particularly on the matter of circumferential oil supply grooves to which reference was made in connection with crank pin bearings. If curve A of Fig. 8 represents the maximum safe film pressures, it may reasonably be assumed that if a supply groove B be added, the film pressure distribution would change to something like that represented by curve C, and the bearing would have one-third the supporting value.

The pressure at which oil is supplied to the bearing is immaterial as long as it reaches the bearing in sufficient quantity at a point of minimum pressure. Pressure is important only so far as it may affect the quantity flowing through the bearing for the purpose of carrying away heat. Obviously in practice oil is supplied at some sensible pressure, say, 5 lb. to 30 lb. per square inch gauge, so that it may be more readily observed by means of a pressure gauge, and so that a small fall of pressure may not result in failure of the supply.

The chemistry of oil is beyond the scope of this paper. For any given purpose a choice of viscosity must be made. The higher the viscosity the greater the distance the film may be carried, and hence results greater safety but greater loss. Higher viscosity oils are accordingly required with lower speeds, at the higher limits of pressure. A viscosity of 150 seconds Saybolt at 100 deg. Fah. is regarded as good practice for high-speed bearings incidental to steam turbine work.

It is important that oil should be free from acid and that it has no tendency to turn acid. This is especially true in the case of lead-base bearing liner mixtures, because lead is soluble in all the fatty acids. It has been found that copper and zinc have the effect of causing oil to turn acid. This is supposed to be because of a catalytic action of certain of the non-ferrous metals. It has therefore become the practice in the United States to avoid copper and bronzes as much as possible in the oiling system, steel piping being universally employed.

Precautions should be taken that the oil has the least possible opportunity to become oxidised, as this results in the formation of sludge. For this reason, unnecessary cascading in reservoirs, &c., is avoided, and it is probable that more attention will be paid to this matter in the future. With the higher viscosity oils an emulsion may be formed should it become mixed with hard water, so that copper and zinc have the effect of causing oil to turn acid. This is supposed to be because of a catalytic action of certain of the non-ferrous metals. It has therefore become the practice in the United States to avoid copper and bronzes as much as possible in the oiling system, steel piping being universally employed.

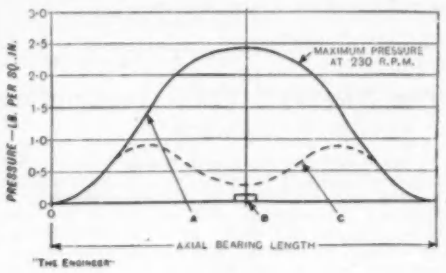


FIG. 8

Precautions should be taken that the oil has the least possible opportunity to become oxidised, as this results in the formation of sludge. For this reason, unnecessary cascading in reservoirs, &c., is avoided, and it is probable that more attention will be paid to this matter in the future. With the higher viscosity oils an emulsion may be formed should it become mixed with hard water, so care must be exercised in design to preclude this possibility.

The dimensions of the oil reservoir of a lubrication system are important. The larger the reservoir, the greater the opportunity for rest and the greater will be the length of life of the oil. Certain committees of engineering associations are endeavouring to standardise the requirement for a ten minutes' supply in the reservoir.

Because of the large quantities of oil in the system at a temperature conducive to chemical reacton, the best method of maintaining oil in good condition has received attention. There are two systems in general practice. One is known as the "fractional filtration" system, in which oil is drawn from the bottom of the reservoir over an overflow device, so that the oil cannot fall below a predetermined level. It is then fed through a pipe to a filter, from which it is returned to the system. The filter may be designed to treat any fraction of the flow through the machine. Usually about 5 per cent. is employed. With this arrangement, the filter system may be placed in and taken out of service without any interference to the operating machine, as an amount overflows from the reservoir equal to that delivered by the filter system. The other, known as the "Batch" system, is to provide a tank system large enough to hold two complete oil supplies for the largest machine in the plant. At intervals of a few months all the oil is removed from any one machine and discharged into a tank in which it is kept warm and stands idle for several weeks. It is then filtered and discharged into a second tank and is ready for use in the next machine. The latter scheme, the author

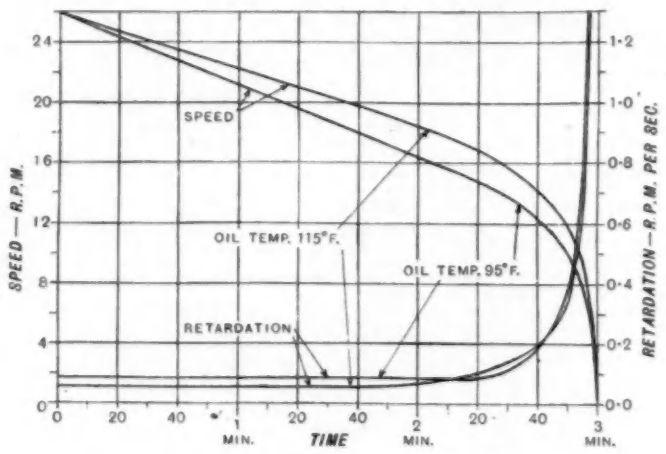


FIG. 4

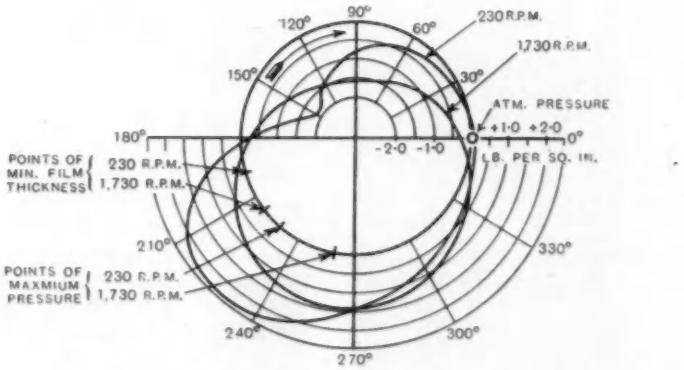


FIG. 6 Fluid Pressures at Mid-length of Bearing.

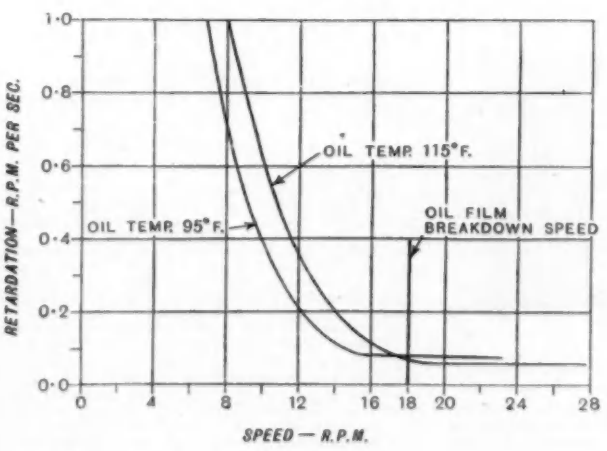


FIG. 5

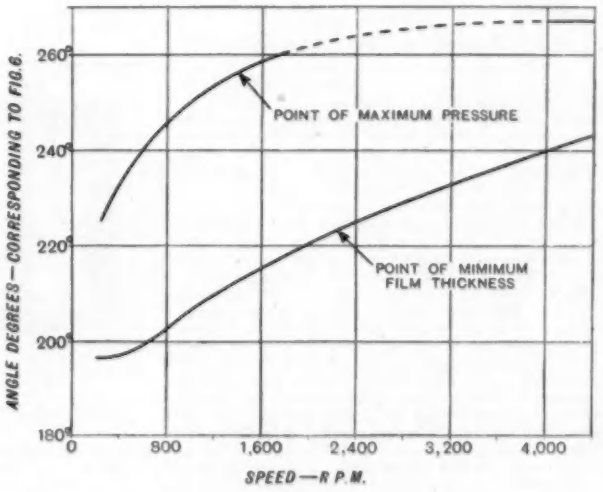


FIG. 7

believes, is regarded by the best authorities as the more satisfactory.

Filter systems of the centrifugal type are not favourably regarded in some quarters because of their alleged tendency to aerate the oil, thus causing subsequent oxidisation.

The author knows of no cases of bearing trouble due directly to the use of too hot oil, excepting cases where the viscosity was lowered to a point unsuitable for the loading and velocity conditions. A temperature of 200 deg. Fah. of the oil leaving the bearings has not infrequently been recorded. It is usual, however, to supply oil cooling surface sufficient to limit the temperature of the oil leaving the bearings to below 140 deg. Fah. A 20 deg. Fah. rise of temperature between ingoing and outgoing oil is regarded as good practice.

The "Relay" Train Description System.

In association with the British Power Signal Company, the Relay Automatic Telephone Company has developed a two-wire train describing and platform indicator system, which was demonstrated at Relay House, Streatham-hill on Friday of last week. It is somewhat surprising that the many devices and circuits employed in automatic telephony switching have not found a wider field of application in connection with railway traffic control, in which flexibility of the apparatus is a most valuable asset. This new "Relay" train description system possesses the flexibility desired, whilst as the apparatus only consists of simple relays it should also possess a high standard of reliability. A signalman controlling a junction has more than one method open to him for passing trains forward; and the actual procedure adopted in each case is determined by the identity of the train. If the traffic is light and the local conditions are such that there cannot be more than one train between the signalman's cabin and the immediately preceding cabin in the up and down direction, the necessary information may be conveyed to him telephonically by code rings, or by other such means. The heavier the traffic, however, the more impracticable does this procedure become, as it takes the memory of

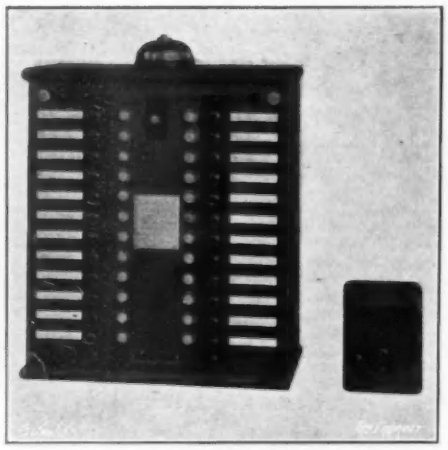


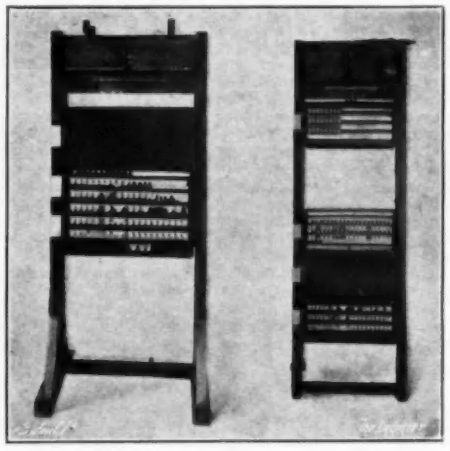
FIG. 1—DESPATCHING KEY AND LAMP CABINET

the signalman, but the difficulty is overcome by the train description system under consideration.

Whenever the signalling system is such that several trains may be approaching between a signalman's cabin and the cabin immediately preceding it, as would be the case when the line between two cabins is divided into several sections controlled by automatic signals, a train description equipment becomes a necessary adjunct to the signalling system. Staff economies may frequently be effected by permanently closing down signal cabins and by installing automatic signals operated by track circuits, resulting in the conditions just mentioned, which render a train description system necessary in order to avoid the additional strain upon the signalman and the risk it involves as a result of him having to memorise or to write down the descriptions of so many trains conveyed to him in some other way.

A feature of the system under consideration is that it only involves the use of two wires between the cabins. The method of transmitting train descriptions from one place to another is similar to that employed in the Relay Automatic Telephone Company's automatic switching system, but in the train describing system transmission is effected under exceptionally favourable conditions as compared with the conditions obtaining in automatic telephony. In the latter case there can be no control over the number of subscribers who may attempt to make calls simultaneously, and it therefore sometimes happens that more traffic is offered than the equipment is designed to accept, with the result that some of the calls may be lost or mutilated. In automatic telephony, moreover, impulses are sent out by a great number of different dials operated by different individuals who send the impulses over lines of different lengths and having different electrical characteristics. In the train describing system under consideration however, the descriptions are always transmitted one at a time from the same transmitter to the same receiving device over the same line and at a speed which renders faults in transmission almost an impossibility. Descriptions are, in the first place, set up by the depression of a key, and, if desired, an opportunity may be provided for the operator to check the description before actually transmitting it, or the setting up and transmission may be effected by the same act.

The transmission takes place on a numerical basis and consists of a series of trains of impulses—1, 2, 3, or even four—the trains employed depending upon the basis of operation of the particular equipment. The descriptions may be transmitted to one cabin or to a series of cabins, and may remain displayed for the time being at the transmitting end as a reminder to the operator of the last train sent. The receiving equipment may be designed to store any number of descriptions, and it may also be arranged so that as many of these descriptions as may be desired may be displayed in the order of their arrival. The re-transmission of descriptions from the receiving cabin may be effected either by the momentary depression of a key, or by the operation of a track circuit or treadle operated by the train itself; but, in any case, it is unnecessary to set up a description which has been received. It may be arranged, however, that in the receiving cabins the operator may set up descriptions which have not been received and transmit them in advance of the descriptions already stored and displayed in his apparatus. In any case, when the receiving operator re-transmits a description or interpolates one of his own, the description last sent can remain displayed for the time being as a reminder to the operator. By the depression of a key the receiving operator can also eliminate descriptions from his apparatus without transmitting them. It may also be arranged that on operating a locking key descriptions



FIGS 2 AND 3—DESPATCHING AND RECEIVING EQUIPMENTS

received in the cabin will be automatically transmitted, thus enabling the cabin to be closed down at times of light traffic without affecting the operation of the train describing system.

The illustrations show an equipment that has been supplied to one of the British railways, and which has been designed to cover twenty-four different descriptions which have been engraved on the labels shown in Figs. 1 and 4. This particular equipment is operated on a three-digit basis, and is capable of dealing with a thousand descriptions, each transmitted as a number. It will be recognised that, as only twenty-four descriptions are actually made use of out of a possible thousand, the margin of safety in the matter of false descriptions is very wide; but it has, nevertheless, been arranged that in the very remote event of a fault in transmission the apparatus will display the description "fault." The depression of any key—to be seen in Fig. 1—causes the corresponding description to be immediately transmitted to the apparatus—to be

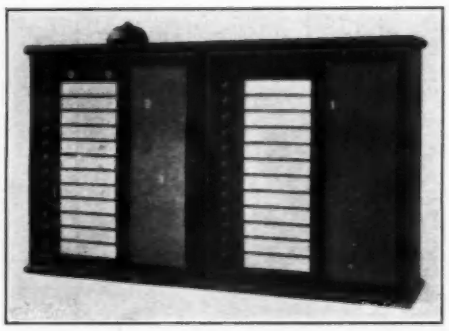


FIG. 4—24-WAY RECEIVING DISPLAY PANEL

seen in Fig. 2—and when the transmission has been completed—in a period not exceeding 2 seconds—the lamp associated with the key lights and remains alight until the key is depressed to send a further description. In this particular case, the receiving equipment is designed to store six descriptions and to display three of them so that from the receiving cabinet six descriptions may be sent before the receiving equipment becomes full up. If an attempt be made to send a seventh description, the depression of the key for that pupose would be quite ineffective, except that the red alarm "line lamp" in the left-hand top corner of the display cabinet would, light and remain alight as long as the distant receiving equipment remains full. The separate key—to be seen in Fig. 1—is for the purpose of extinguishing the lamp corresponding to the last train sent when it is not desired to send further descriptions, as, for instance, on closing down the cabin at night.

In Figs. 3 and 4, the receiving equipment is shown with space on the apparatus rack—Fig. 3—for re-transmitting facilities to be added at a later date. The display cabinets—Fig. 4—merely consist of labels with a common ground glass screen, behind which stencils and lamps are provided for illuminating the screen, thus displaying in the order 1, 2, 3 the next three trains to arrive. As re-transmitting facilities are not initially provided for on this particular equipment, the positions for lamps at the left-hand side of the cabinets are for the time being occupied by blanks, but when re-transmission is brought into use, lamps will remind the operator of the last description re-transmitted. It is obvious that in the apparatus described there are all the elements required for the purpose of platform indication to the public. All that is needed for this purpose is an apparatus as shown in Fig. 4, but constructed so that it is suitable for use on platforms. The illustrations relate to a form of display which may be described as verbal, the three-digit number employed for the transmission of any given description resulting in the lighting up of a lamp much in the same way as the number employed in automatic telephone systems results in the ringing of an individual bell, but it is quite simple matter to display the descriptions in their numerical form, either upon a 1, 2, 3 or 4-digit basis, as may be required by the particular conditions.

THE INSTITUTION OF CIVIL ENGINEERS.

OCTOBER EXAMINATIONS, 1929.—PASS LIST (*INTERIM*)

Preliminary (56).—F. S. A. Bather, G. Berry, J. P. Beveridge, C. Birtwell, J. Blackwell, S. R. Broderick, G. P. Bull, R. W. Bullmore, R. C. Cheyne, E. W. F. Clements, A. V. Currie, F. W. Curry, J. J. Davies, R. Dewsberry, A. J. Egerton, P. W. Godfrey, E. G. Goldring, E. Gooseman, J. E. Guest, W. G. Haggie, F. J. Hegan, R. Herring, T. D. Heynes, J. Hodgson, C. P. Hosking, W. Johnson, H. A. Leader, A. W. McLean, J. C. Maxwell-Cook, A. H. Maynard, P. J. Metcalf, R. Mountstephens, H. Nicholson, P. Nye, T. Pritchard, E. F. G. Ray, T. C. Richards, C. M. Roberts, J. L. Scott, T. D. Sellman, V. J. Sevian, J. L. Sharratt, J. G. Smith, K. R. Stones, A. Sutherland, J. J. Taylor, R. M. Thomas, C. B. A. Turner, H. G. Walker, C. G. Wanhill, L. C. Waters, E. H. White, J. Whittaker, H. W. Willcock, G. D. Wyatt, J. Wyse.

ASSOCIATE MEMBERSHIP (142).

Whole Examination (*Sections A, B and C* (2).—R. I. Bataline, E. A. Turner.

Sections A and B only (9).—J. Anderson, J. Arrol, R. S. Drake, R. F. Heaney, A. S. Lowe, H. P. Pooley, E. L. Snell, H. M. Watson, W. E. Wright.

Sections A and C only (4).—H. G. W. Cook, G. Shaw, G. G. Watson, D. M. Waite.

Sections B and C only (5).—H. J. W. Buick, L. Essayed, T. L. Farnes, R. F. Lowe, I. MacK. MacLean.

Section A only (58).—W. B. Acton, R. A. H. Allen, F. R. L. Barnwell, E. Bateson, J. E. Belbin, A. T. Black, W. Bowden, T. L. Bowring, D. L. Brown, G. W. Bruce, C. L. Burgess, A. Burrows, R. D. Chalcraft, G. F. Clifford, K. A. Cole, J. V. Cook, C. S. Crump, M. N. Dalal, E. F. H. D'Ath, H. R. Davenport, I. L. D. Davies, J. H. Dossett, J. W. Dunn, T. G. Elliott, A. J. Felstead, S. A. Findlay, W. H. Gamble, T. H. Higson, C. Hodgson, E. Howard, R. A. Japp, W. G. King, W. B. Lawson, R. A. Lyall, G. N. McCarthy, P. Macfarlane, R. L. McIlmoyle, J. R. Maden, R. Marshall, J. C. Martin, N. A. Matheson, H. Millican, D. T. Owen, J. S. Robson, S. J. D. Russell, W. H. Sebley, J. D. Sheasby, F. W. Slade, F. Smith, C. H. S. Spaull, P. M. Spencer, T. H. Stayman, H. V. Steggles, A. N. Sutherland, C. K. Tallack, F. Waite, J. B. White, D. J. MacG. Williamson.

Section B only (17).—J. Andrew, F. Bardsley, E. S. Benson, H. G. Buxton, F. H. Clark, H. L. Folkes, J. B. Footner, D. Garden, T. D. Hackney, W. B. Lyall, N. J. Pugh, G. W. Roberts, C. H. Smith, J. A. Stirling, E. Sykes, N. E. Westerhout, T. F. R. Wilson.

Section C only (47).—F. V. Appleby, B.Sc. (Birmingham), I. A. Badawy, E. M. Barnes, B.Sc. Eng. (Lond.), A. Borlase, J. Brown, B.Sc. (Belfast), E. Burke, B.Sc. Eng. (Lond.), W. H. Burren, E. R. Cheesman, A. G. Copsey, H. G. Cousins, B.Sc. Eng. (Lond.), F. H. Creed, B.Sc. Eng. (Lond.), H. M. Everett, J. F. Firth-Hand, R. G. Gallien, F. R. Gaskell, A. H. Gillard, B. W. Hadfield, J. D. How, H. S. Hvistendahl, B.Sc. Eng. (Lond.), A. Inglis, D. G. MacCormack, B.Sc. (Glas.), J. E. G. Palmer, B.A. (Cantab.), R. W. Palmer, B.Sc. (Bristol), A. Parker, F. L. Pasley, E. R. Peet, B.A.I. (Dublin), A. N. Procter, B.Sc. Eng. (Lond.), F. A. Railton, B.Sc. (Wales), W. J. Rankin, E. M. Rowland, B.A. (Cantab.), S. E. Sherwood, B.Sc. (Birmingham), M. W. Summers, D. C. Summerton, B.Sc. (Birmingham), E. E. Sweeting, J. Telfer, B.Sc. (Edin.), S. P. Thompson, B.Sc. (Leeds), W. E. Thorowgood, A. E. C. Trimble, B.A.I. (Dublin), J. H. W. Turner, B.Sc. (Glas.), R. J. C. Tweed, B.A. (Cantab.), D. M. Walker, B.Eng. (Sheffield), F. C. Walls, T. W. Weldhen, B.Sc. Eng. (Lond.), M. T. B. Whitson, B.Sc. (Edin.), G. A. Wood, B.Eng. (Sheffield), F. R. Wright, L. de Zinovieff.

The results of the examinations held abroad will be announced later.

RADIO LECTURES.—The Marconiphone Company has prepared three lectures, each illustrated with lantern slides, which may be read before societies. The subjects dealt with are:—(1) "Screen Grid Valves and Circuits," (2) "A.C. Valves and Circuits," and (3) "Public Speech and Music Amplifiers." Each is timed to last from thirty-five to forty-five minutes when accompanied by its series of fifteen to twenty slides illustrating the construction, appearance and use of the apparatus under discussion. Secretaries and members of societies who are interested should write to the Marconiphone Company, Ltd., Department I.D., 210–212, Tottenham Court-road, London, W.1.

A DIARY FOR ADVERTISERS.—We have received a copy of a new diary and reference book which has been prepared to meet the many requirements of newspaper advertisers. Although small in size, it contains a large amount of valuable information in a condensed form. It deals with styles of type and borders, tone and line blocks, sizes of paper, and the correction of proofs. A useful feature is a ready reckoner, whereby the area of any sized block up to 8¼in. in width and 10in. in depth may be seen at a glance. Additional information includes a classified press directory and a directory of commission agents, together with commission tables giving commissions at different percentages on any amount up to £100. The diary, which we believe to be new with respect to the matters dealt with, may be obtained from Mr. H. E. Hancock, Effingham House, Arundel-street, Strand, W.C. 2.

CABLE RESEARCH HANDBOOK.—We have received a copy of a volume which is being issued by Commercial Secretaries, Ltd., Imperial House, Kingsway, W.C. 2, on behalf of the cable research associated firms, and which contains those rules, regulations and specifications which are considered to be most largely used by engineers and others directly interested in the buying, laying and operating of cables and overhead line conductors for transmission of energy, telephony, telegraphy, &c. It opens with the Electricity Supply Act of 1882 and all the amending Acts and memoranda which have appeared up to 1926; then come the Regulations issued by various authorities, and finally the B.E.S.A. specifications germane to the subject. The book is being distributed widely amongst people interested, and whilst it is published at the price of one guinea, anyone associated with the industry or in any way properly interested in the subject can obtain copies free by posting a request to the Secretary of Commercial Secretaries, Ltd.

THE EVOLUTION OF RAILWAYS.

From September 14th to September 21st, 1930, Liverpool will celebrate the centenary of the opening of the Liverpool–Manchester Railway. The celebrations are being planned on an ambitious scale, and it is hoped that they will attract a very large number of overseas visitors. Included in the scheme are special pageants, both railway and civic, a comprehensive Evolution of Transport Procession, and two Exhibitions. Of these Exhibitions, the first will comprise the heavier exhibits—railway locomotives, rolling stock, &c.—dating from the beginnings of railway history. The second will comprise :—(*a*) Railway posters ; (*b*) historical literature ; (*c*) railway prints, etchings, &c.; (*d*) models of railway locomotives and rolling stock, old and new, model railways, model signalling systems, &c. &c.—in fact, everything that will help to illustrate a landmark in railway history and is at the same time not too large to be included in a covered exhibition of no exceptional magnitude.

The Executive Committee, which consists of representatives of the civic and railway interests, will be grateful for information from everyone interested in the development of railways who can supply information as to the whereabouts of historical exhibits or would be prepared to lend such exhibits. Communications should be addressed to the general secretary, Liverpool–Manchester Railway Centenary Celebrations Committee, 357, Royal Liver Building, Liverpool.

BEYER-GARRATT LOCOMOTIVES IN S. AFRICA.

In our issue of August 2nd, we referred to a new class of Beyer-Garratt locomotive recently designed and manufactured by Beyer, Peacock and Co., Ltd., Manchester, and shipped for service on the South African Railways.

These locomotives, two in number, weigh 214 tons each and develop a tractive effort at 85 per cent. of the boiler pressure of 89,136 lb. They are the most powerful steam locomotives yet built in Europe for freight work, and when it is remembered that they work on a 3ft. 6in. gauge, it will be admitted that they show a very notable development of the articulated engine.

We understand that the preliminary tests with the first of these locomotives have been carried out on the new deviation line between Durban and Cato Ridge section, 44 miles in length, containing some 35 miles of 1 in 66 compensated gradients. Prior to the advent of these engines, the load for the mountain class of engine in use, which has a tractive effort of 42,350 lb., was 500 tons, double heading not being permitted in view of the considerable number of tunnels on the section. This load was timed at an average speed of 14·8 m.p.h. on the ruling gradient.

On October 21st the new engine took a load of 1117 tons over the section at an average speed of 16·4 m.p.h. without the slightest trouble. This is the heaviest load ever hauled up the mountain section and is also the biggest load ever hauled on such a gradient on the South African Railways. Since the running of this test load, a further increase in tonnage has been taken, namely, 1205 tons, and time was made up on the way to Cato Ridge. The engine operates up the gradients cab first, thus minimising trouble with smoke in the tunnels. It is understood that no inconvenience has so far been experienced from this cause.

A New Siamese Gunboat.—At the Barrow-in-Furness Naval Construction Yard of Vickers-Armstrongs on Tuesday last, November 19th, the launch took place of the 173ft., 1000-ton displacement river gunboat "Sukhodaya," which has been built for river estuary and coastline patrol service. The new ship is armoured and she carries two 6in. guns, one forward and one aft and four high-angle guns amidships, with the latest ammunition and fire-control arrangements. The propelling machinery comprises twin-screw triple-expansion engines, designed to develop a total of 850 I.H.P. at 150 r.p.m., and with 225 lb. boiler pressure. Two oil-fired water-tube boilers are fitted, and the auxiliaries are of the most modern type, including Weir regenerative condensers. The designed speed of the ship is 12 knots.

Institution of Electrical Engineers.—The annual dinner of the North-Western Centre of the Institution of Electrical Engineers was held at the Midland Hotel, Manchester, on Tuesday last, under the chairmanship of Mr. T. E. Herbert, the chairman of the branch. There was a very large attendance of members and guests. The toast of the "Institution of Electrical Engineers," proposed by Lord Colwyn, was responded to by the President, Colonel T. F. Purves. In proposing the toast of the "Cities and Trade of Manchester and Salford," Dr. H. Levinstein, chairman of the Society of Chemical Industries, called attention to the loss to the staple trade of the district occasioned by the number of times the raw material, cotton, was handled between the docks and the mills. He advocated the erection of a series of factories adjacent to the Ship Canal, where the complete processes of spinning, weaving, dyeing, and bleaching could be carried out with only once handling. He said that at present the extra transport required must cost something like £1,000,000 a year.

The British Electrical and Allied Manufacturers' Association.—The annual dinner of the British Electrical and Allied Manufacturers' Association was held at the Connaught Rooms on Wednesday last, when the Earl of Derby presided. In proposing the toast "Electricity in Industry and Transport," Mr. J. H. Thomas, Lord Privy Seal, said that as a nation we advertised our difficulties better than we advertised our goods, and one result of that continuous advertisement of our troubles was that customers abroad turned away from us. The prosperity of the electrical industry was a good answer to those who doubted whether we could make an effort and whether, if we did, we could compete against the world. The volume of exports of electrical goods and apparatus had risen since 1924 by 15 per cent., and the increase had no doubt been helped by the fall in costs. In the past seven months orders for heavy electrical plant to the value of £7,000,000 had been obtained from abroad in the face of foreign competition. In responding, Sir Felix Pole, chairman of Associated Electrical Industries, Ltd., asked the railway companies, municipal corporations, statutory supply undertakings, &c., to patronise home industries. The Earl of Derby, in submitting the toast "The Guests," said that the Government was to be pitied rather than attacked at the present time. To run a country like ours required skill, courage, and endurance, and he was one of those who, while not ready to surrender their principles in some matters, was prepared to co-operate in every possible way. Mr. Herbert Morrison, Minister of Transport, responded.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Situation Unchanged.

There has been no improvement in demand for iron and steel in this area during the past week, neither has there been any alteration of note in selling values. Frankly, the market is quiet for the time of the year, and buying is unusually restricted. To some extent this is due to the fact that consumers, just before the quarter opened, arranged for their known needs to be supplied to the end of the year, the possibility of a higher range of values causing them to act more quickly than is generally the case in the last quarter of the year. In so far as this is borne in mind, the present market quietude does not necessarily signify dull conditions in the iron and steel-consuming industries. The outlook is uncertain, however, and nothing but necessary material is being purchased. The October trading returns furnish some interesting statistics, and they are being remarked upon in business circles hereabouts at date. While the amount of iron and steel imported in October—248,499 tons—was 19,000 tons more than in September, it was nearly 7000 tons less than in August. The tonnage was also smaller than that imported in the corresponding month last year and very much smaller than the total for October, 1927. The monthly average of imports during the third quarter of this year was 240,496 tons, and for the nine months 229,033 tons. Though imports increased last month, so did exports. While October imports of iron and steel were 19,000 tons greater than those in September, exports expanded by 91,000 tons. The total, 390,444 tons, was the best recorded since the heavy shipments of May, when 442,774 tons of iron and steel were sent abroad from this country.

Pig Iron.

Pig iron business is being steadily maintained in the Midland district, deliveries in good quantities being made in foundry iron against contracts. While there is little in the nature of new business coming on to the market, some old contracts which have run out are being renewed. It is worthy of note that production of pig iron the kingdom over in October was the highest total this year, although the number of furnaces in blast at the end of the month was fewer by two than at the end of the previous month. Output of pig iron last month amounted to 688,700 tons. It would appear that home consumption has improved, for the official trading statistics show that we are making very little impression indeed in foreign markets, exports being much as they were a year ago. Certainly our export trade made some recovery last month after the disappointing trading of September, but the tonnage exported does not give cause for jubilation. It gives some satisfaction to note that the upward movement in imports of foundry pig iron was reversed last month. There was, however, an increase in imports of basic pig. The forges and foundries in the Midlands are steadily employed, particularly the former, and considerable tonnages of raw iron are regularly consumed. Derbyshire and Northamptonshire blast-furnacemen who have this week sought to arrange for supplies of furnace coke for January next have been met with a demand for at least 1s. per ton in excess of present coke values. This they appear unwilling to pay, and the placing of business for the new year is withheld. Uncertainty prevails in the fuel industry generally. Derbyshire and Northamptonshire pig irons are being sold on the minimum basis laid down by the Central Pig Iron Producers' Association. Derbyshire No. 3 foundry is £3 18s. 6d. and Northamptonshire £3 15s. Forge irons are 4s. per ton below these prices.

Finished Iron.

The finished iron industry in Staffordshire presents no new feature, conditions remaining much as they have done for some months past. Regular bookings are being made for marked bars, and in this department ironmasters are relieved of anxiety as to the regular working of the mills up till the end of the year. Prospects also are considered good, and there should be a substantial reinforcement of order books between now and then. The price is unchanged at £12 10s. per ton. There is no improvement in the demand for Crown iron, selling prices of which vary from £10 to £10 7s. 6d. Makers from outside this district continue to compete on the Birmingham market. They offer Crown bars at from £9 15s. upward. Nut and bolt bars are a small trade at £9 upward. A good deal of cheap Continental iron is going into the local works. The nut and bolt industry in the Black Country is rather quieter, the demand for black bolts and nuts being, at date, dull. The chain trade, likewise, is not very brisk, and its requirements of material are small. The iron strip mills are running regularly. Wrought iron gas tube strip sells steadily at £11 2s. 6d. Ironmasters express some surprise that the trading returns should show exports of finished iron in October to be nearly twice as large as in September.

Steel.

Business in steel is restricted and many of the mills are in need of orders. Particularly does that apply to the finished steel department, in which the quietness in the Midland constructional engineering yards is adversely affecting demand. In the half-products branch the uncertainty of the continental situation is causing consumers to withhold business. This week the firmer tone in foreign bars and billets has been maintained, and it is thought very probable that in the near future the disparity between native and foreign semis will become less wide. Re-rollers, in Staffordshire at any rate, view the future with increased hope. Native prices, alike for finished and semi-finished steel, show no change on the week, nor has there been any marked alteration in foreign quotations. Though a considerable transfer of business from home mills to those of continental producers of steel blooms and billets has recently been spoken of, the trade figures for last month record only a slight increase in October of imports of these materials. The difference was less than the variation of two working days between September and October. Moreover, the amount of this class of material imported during the past two months was 24,000 tons less than in the preceding two months. It is noted, however, with some regret, that imports of bar iron, rods, sections, &c., were larger than in September, which in turn were in advance of August. On the other side there was a decided improvement in exports of steel girders, beams, joists, &c. The total leapt from 6097 tons in September to 11,523 tons in October. Exports of hoops and strip were not quite so satisfactory. The output of steel in this country during October totalled 889,800 tons. This is an improvement on any month this year.

Galvanised Sheets.

Values of galvanised sheets have undergone further weakening. Consumers demand the full benefit of the low prices for sheet bars and spelter which now rule, and such is the state of the order books at the sheet mills that millowners are unable to resist. Twenty-four gauge galvanised corrugated sheets have been disposed of this week at £12 15s., though most mills quote £12 17s. 6d. and some £13. Though exports of galvanised sheets were better last month than in the one immediately preceding it, there appears to have been another relapse. In October 62,000 tons were exported, an advance of 16,000 tons on the September exports, but it is feared the November returns will not make such pleasant reading. The chief buying market at date is South America. Demands from home consumers are also small and the industry is badly in need of orders.

Scrap.

Reports to hand in Birmingham this week indicate a glut of heavy steel scrap at some of the Welsh works. Consumers have no need to make fresh purchases and the market is extremely quiet. Quotations are unchanged from last week.

Big Orders for Midlands.

Some substantial orders for railway rolling stock for the Rhodesia Railways have just been received by Midland firms. The Metropolitan-Cammell Carriage, Wagon and Finance Company, of Saltley, is to supply 150 steel wagons and 150 bogie 45 tons capacity wagons, the Birmingham Railway Carriage and Wagon Company 100 20-ton wagons, and the Gloucester Railway Carriage and Wagon Company 6 first-class passenger coaches.

Large Power Press.

One of the largest power presses in the country, a toggle draw-in press with triple action, has just been installed in one of the large Birmingham works. The press is applied to the production of steel body panels for saloon motor cars. The press stands 20ft. and weighs nearly 200 tons. Part of the structure is in a pit, the foundations containing 150 tons of concrete. The biggest single casting is the crown, which weighs 23 tons. The weight of the bed is 19 tons and the slide 15 tons. The heaviest dies weigh 10 to 12 tons. The main drive is by a 75 h.p. electric motor, an auxiliary 10 h.p. motor providing for the adjustment of the inner slides. With a speed of five and a half strokes a minute the press is capable of producing a pressing at every stroke.

Unemployment.

A further decline in unemployment in the Midlands of 4167 brings the grand total down to 152,894. The only districts which, on the week, show increases are Bilston, Dudley, Derby, Northampton, Peterborough, West Bromwich and Worcester. The number of workless in Birmingham is now 23,591, and at Coventry 3074. Of the total unemployed 114,590 are men, 32,950 women, 2839 boys and 2515 girls.

LANCASHIRE.

(*From our own Correspondents.*)

Manchester.

Fall in Textile Machinery Exports.

Textile machinists have no good reason for satisfaction with the present position of export markets, as reflected in the trade returns for October. On the showing for that month, there has been a progressive decline compared with the corresponding period two years ago, when shipments of textile machinery reached a total value of £1,041,000. This fell to £944,000 a year ago and to £838,000 during the month under review. Last month's exports included 6517 tons of spinning and twisting machinery, valued at £626,800, and 1325 tons of weaving machinery, valued at £119,230. The decline cannot be attributed in any important degree to the fact that the Russian market has reached almost vanishing point, for few markets have not suffered a contraction. British India continues to take the lead with imports of textile machinery valued at £267,861, followed by Japan with £77,221, France £58,246, China £49,829, Germany £42,630, the United States £42,335, the Netherlands £36,210, South America £27,334, Australia £25,703, and Russia £16,051, other European countries being responsible for shipments of an aggregate value of £156,518.

The Longer View.

Fortunately, taking a longer view over the completed ten months of this year, the position is much less unsatisfactory, and it is to be hoped that the October figures are indicative of nothing more than a lull. January-October exports this year amounted to 106,175 tons, valued at £9,742,000, against 103,592 tons and £9,745,163 in the ten months of last year, and 96,983 tons and £9,541,000 in 1927. A marked improvement in aggregate

exports to British India, Japan, China, France, the United States and Australia has almost exactly counterbalanced the declines compared with a year ago in the takings of South America, the Netherlands, Germany, Russia, and other European countries.

£200,000 River Dam ?

A scheme is to be submitted to the Main Roads and Bridges Committee of the Lancashire County Council by various local authorities in the Fylde district of Lancashire for the construction of a new bridge and main road over the river Wyre, "about 4 miles from where the river enters the sea at Fleetwood." In connection with the scheme, a proposal has been made by a Lancashire engineer to construct a dam across the Wyre, at an estimated cost of between £150,000 and £200,000, one object being to generate current by tidal power, though it remains to be seen whether this proposal will be acted upon by the authorities.

Back to Full Time.

It is reported that about 10,000 men will be affected by the decision of the London, Midland and Scottish Railway to resume full-time working at Crewe works as from the end of next week. Since early in the year working time at Crewe has been restricted to five days a week.

Obituary.

The death took place at Cheetham, Manchester, last Sunday, of Mr. John Ashley, who was well known in constructional engineering circles locally, having been concerned as clerk of works in the construction of a number of important buildings in this country and abroad. For a number of years he was in the service of Mather and Platt, Ltd., formerly of Park Works, Salford, and now of Newton Heath, Manchester, and previous to that was employed by Edward Wood and Co., Ltd., of the Ocean Ironworks, Salford.

Non-ferrous Metals.

All sections of the market for non-ferrous metals have worn a very different appearance since my last report, and there has been a distinct general recovery after the weakness in evidence a week ago, all metals, with the exception of lead, having fully recovered the whole of the previous loss. In the case of tin, current values represent a gain on balance for the week of about £4 10s. per ton. Bearish influences have been less in evidence and prices have responded to some extent to the fair weight of buying that has been going on. Similar factors have operated in the copper section, and, coupled with more cheerful American advices, quotations have moved to a higher level than was current at the beginning of the month. Whilst, however, the movement of standard brands of copper has been reasonably brisk, users of refined descriptions have continued to operate sparingly. Lead has attracted a fair amount of attention, and the tone of this section has been steadier, to some extent in sympathy with the other metals. The low level to which spelter sank last week was a powerful magnet to a good many buyers, and a rise of well over £1 a ton was a partial result.

Iron and Steel.

The condition of the pig iron section of the markets here has not been unsatisfactory this week. There has been a definite contraction of forward buying interest, in consequence of the fact that Midland prices have been definitely stabilised until the end of January. On the other hand, buying for replacement purposes is on a fairly normal scale, and, moreover, contract deliveries to Lancashire foundries seem to be fully up to their recent level. For delivery in the Manchester zone Staffordshire and Derbyshire iron is at 77s. per ton, Scottish at up to 93s. 6d., and hematite at about 90s. The demand for bar iron is still quiet, but prices are well held at £10 15s. per ton for Lancashire Crown bars and £9 15s. for seconds material. In the home steel section virtually the only change in the price situation has been a slight stiffening in quotations on this market for boiler plates, acid and basic qualities this week being at £10 per ton. Inquiry for these materials, however, has been less active since my last report, although so far this is not taken to mean any serious slackening of activity in this branch of engineering. In spite of the fact that inquiries in the constructional engineering section have been rather more numerous of late there has been no actual improvement in business, and complaint from rollers is pretty general as to the falling away in the quantities of steel material covered by specifications. Bright drawn bars, however, continue to move off in good quantities. Sections and joists are quoted at £8 2s. 6d. per ton, tank plates at £8 17s. 6d., large bars at £9 2s. 6d., and small re-rolled bars at £8 5s. to £8 7s. 6d.

BARROW-IN-FURNESS.

Hematite.

The hematite pig iron trade still remains active, but there does not appear to be the same steadiness about it. Makers are clearing their productions, and as evidence of that there are practically no stocks in existence. Still, there are signs of unevenness in the market which may mean a slight falling off in the bulk of business on the whole. The trade with the Continent is maintained, and has mostly to do with special qualities of iron of stated analysis. Deliveries to America continue and the cargoes from Barrow include iron from several firms in the district. A cargo leaves Barrow this week to cross the Western ocean and there are more part cargoes to follow. The local iron ore trade is steady, and is likely to be so long as the present production is maintained. Foreign ore is in steady demand. The steel market continues to be dull, and there are not many orders coming in. One Australian order for rails is being dealt with in Australia instead of coming to this country. There have been orders for South America, but the tonnage is not as heavy as was hoped. None of the rail mills carry orders which will take them any length of time to complete and fresh orders would be welcomed.

SHEFFIELD.

(From our own Correspondent.)

A More Hopeful Feeling.

THE feeling in the east end of Sheffield just now is more optimistic than it has been for some time, so far as the heavy finished steel branch is concerned, as a number of good orders have been booked during the past fortnight, while several firms are better employed. One establishment in which increased activity is being displayed is the Atlas Works of John Brown and Co., whose work programme last week was the largest, in tonnage and value, in seven years. The firm is well employed on heavy forgings, for hollow rolled drums and containers, railway axles and tires, and also has on hand some good orders for general steel material. Its three electric furnaces are fully at work, and an additional Siemens furnace has been started. Some of the orders will be executed in a short time, while others will keep certain departments occupied for months. At Vickers' works, too, there is greater activity in some sections, particularly in drop stampings, of which a large tonnage is being produced.

Armour-plate Rolling.

I have had very few opportunities during recent years of recording much activity at the armour-plate rolling mills of Sheffield, but two of them—those of Vickers and Browns—are now employed. They have been started to roll the plates for two Spanish cruisers. The weight required, being considerably less than 1000 tons, is small in comparison with pre-war orders, and the work will not take long to execute, but it is very welcome after such a long period of slackness in the department.

Basic Steel Declines.

While the acid branch of steel production shows a slight improvement, the basic steel department, after a considerable spell of good employment, is now showing a falling off. That is partly due to a revival of competition from the Continent, where the home demand has slackened off and prices have been reduced, and it is also thought that the financial situation in America is having a detrimental effect on trade. Whatever the cause, the demand for crude basic steel has shrunk to such an extent of late, that firms engaged in its production have closed down some of their furnaces. On the whole, there are fewer open-hearth furnaces at work at present than any previous period of this year. At Templeborough the number in commission is seven out of fourteen; at the old works of the United Steel Companies four out of fourteen: and at Cammells' Penistone Works one out of six. Not only are actual orders fewer, but inquiries relate to smaller tonnages.

The Lighter Side.

In the lighter branches of the steel trade, which include many special manufactures, the situation continues more favourable than in the heavy. The demand for stainless, non-corrodible, and heat-resisting steels is continually expanding, and some firms are finding it difficult to deal with their orders. Stampings and forgings for the automobile trade continue to be produced in very large quantities, and there is also a capital business in cold-rolled steel strip, best wire, and alloy steels. A good deal is being done at the foundries in the production of steel castings for machinery of various kinds, but there is not much demand for railway castings. The rolling mills have experienced a falling off in trade, and there has also been some decline in tool steel. A large volume of trade is being done in tools for engineers, mechanics, and quarrymen; but the factories producing tools for agriculture and steel parts for farm machinery and implements are quiet.

Work for Overseas.

Messrs. Markham and Co., of the Broad Oaks Ironworks, Chesterfield, have now completed one of a pair of hydro-turbines to be employed in the generation of electricity, which they are making for the New Zealand Government, to the order of Boving and Co., of London. The first of the pair, which is of 23,000 horse-power, was dispatched to Liverpool on Sunday. A train of about twenty trucks was necessary to transport the various parts, which had an aggregate weight of from 170 to 180 tons. One casting, the turbine runner, which has a diameter of 15ft., weighs 22 tons. It is expected that the second turbine will be ready for dispatch in about six weeks. Sheffield is also interested in the order for £500,000 worth of rolling stock just placed with British firms by the Rhodesia Railways. In all, 431 carriages and wagons have been ordered, and of these 150 steel wagons and 150 bogie 45-tons capacity wagons are to be made by the Metropolitan-Cammell Carriage, Wagon and Finance Company.

Cutlery and Plate.

Continued briskness is reported in the cutlery and plate trades, owing to the special seasonal demand, and although the call is largely for the cheaper qualities, the output of best goods is also on a considerable scale. Certain firms which confine themselves to the highest quality find a continuous demand for their products, and that demand appears to be growing, although slowly. The production of stainless table knives at the moment is believed to be larger than at the corresponding period of a year ago. In the scissors branch trade is briaker than it has been for many years. A good trade is being done in knives used for industrial and craft purposes. Very large orders for stainless knives, and also for various small articles of cutlery and electro-plate, have been placed by several cigarette firms, who intend them for coupon distribution. The export trade in cutlery is equal to recent averages. The October figures showed an improvement on September, but were £18,000 down as compared with September of 1928. There was a fall in the export of safety razors and blanks, chiefly the latter. Imports of cutlery for the month, valued at £56,325, showed a considerable increase. For best electro-plate the demand is pretty good, but not exactly strong, but there is a large call for cheap cased articles. A fair amount of activity is to be found in the sterling silver trade.

Steel-making at a University.

A university possessing a metallurgical department that is capable of producing a 36-cwt. steel ingot is a notable institution. Sheffield has such a university, which is wonderfully equipped for research and teaching in the Sheffield trades, and the achievement referred to is brought out in the annual report of the Council. It is stated that during the year the open-hearth furnace was run for an experimental period, enlarged so as to take 2½ tons, and ingots were cast of which the three largest weighed 36 cwt. "This is of more than departmental significance," continues the report, "since the Sheffield equipment for large-scale production is unique, and this particular experiment could not have been tried in any other teaching institution in the world. To facilitate the further use of this furnace, the Steel Ingots Committee of the Iron and Steel Institute has offered a grant of £200 towards the expense of running the furnace for another fortnight, on condition that we supply them with six similar ingots for further investigation."

Peak District Cement Works.

The new cement works which G. and T. Earle, Ltd., of Hull, have erected at Hope, in the Peak District, near Sheffield, are now in operation, and were formally opened last week by Mr. J. H. Thomas, the Lord Privy Seal. The works have a capacity for the manufacture of 3500 tons of Portland cement per week.

NORTH OF ENGLAND.

(From our own Correspondent.)

The Trade Outlook.

THE general trade situation in the North of England is distinctly encouraging, and all the indications point to a continuance of the activity which has characterised the various branches of industry for some months past. The recent influx of orders for shipbuilding and iron and steel has created a feeling of confidence in the future. The greater readiness among iron and steel consumers to buy ahead now noticeable affords ample ground for the opinion that trade is gaining strength, and already manufacturers have orders in hand to ensure active conditions at the works well into next year. The improved shipbuilding outlook promises to have a beneficial influence, and departments directly concerned are already feeling the effect. Economic conditions, however, continue perturbing, as prices of iron and steel do not promise to advance in proportion to rise in cost of production. Just at present certain raw materials are somewhat less firm than of late, but the slight ease in values is expected to be of short duration. The coal trade seems to have entered upon a new era, and more and more work is coming forward in the engineering trades.

Cleveland Iron Trade.

The whole of the present output of Cleveland pig iron is going into immediate consumption, and the demand continues on a fairly good scale. Stocks are very low, and makers are confidently looking forward to a marked expansion in the demand. Merchants' holdings are small and buyers cannot obtain price concessions from second hands so readily as of late. Further moderate sales to home consumers for delivery to the end of next month are reported, and a few further contracts for supply over periods next year have been placed. Much of the output is going into direct use at producers' own consuming works. The import of foreign iron into the Tees has ceased, but, on the other hand, the export trade shows little signs of increasing. Prices are firmly maintained, No. 1 Cleveland foundry iron being 75s.; No. 3 G.M.B., 72s. 6d.; No. 4 foundry, 71s. 6d.; and No. 4 forge, 71s.

Hematite Pig Iron.

The position in the East Coast hematite pig iron trade shows little change on the week. Producers are understood to have disposed of considerably more iron than they have in stock. Several contracts are for delivery over the first quarter of next year, and makers are not inclined to commit themselves further except at advanced rates. Both home and continental customers are prepared to enter into further purchases at about terms recently accepted, but producers are not disposed to entertain such offers. Quotations vary somewhat, but the basis for early delivery may be put at 78s. for ordinary qualities. Cost of production is declared to be 80s. For forward supply ordinary descriptions are quoted 81s. and upwards, with No. 1 quality at a premium of 6d. per ton.

Iron-making Materials.

The foreign ore trade is not so firm in tone, but the easier feeling is regarded as temporary, and while odd lots might be purchased at a little below recognised rates, there is no quotable change in market prices, which are ruled by best Rubio at 24s. c.i.f. Tees. A cheapening of Durham blast-furnace coke is attributable to reduction in consumption. Good average qualities are obtainable at 23s. 6d. delivered to works in this area, but supply is still far from plentiful.

Manufactured Iron and Steel.

Big outputs are being maintained in the manufactured iron and steel trade, and works have orders in hand that will keep them very active well into next year. Quotations keep strong, and prices of some commodities may be advanced in the near future. Shipbuilding requisites find a ready market, and constructional steel is selling fairly well. Semi-finished steel is slow of sale just now, due to underselling by continental firms, but works have very substantial contracts to execute. The

galvanised sheet trade is quiet, but producers are well sold. Business in steel scrap is not brisk, consumers having fair quantities on hand and being unwilling to pay the prices asked.

The Coal Trade.

The Northern coal trade position is strengthening as the year draws to its close. In Northumberland best steams are exceedingly firm and are indicating 17s., not only for prompt but for the early part of next year as well. Steam smalls are also advancing in value. In Durham steams are likewise the best feature, and are probably being helped by the fact that Germany is not inclined to extend quantities to former customers, but is renewing contracts largely on the basis of previous business. Poland, too, is well sold ahead, and, wintry weather conditions having set in earlier than usual, there has been a sharp stimulus to the demand. Consumers in Northern Europe have not forgotten the hardships which followed the severe frost last February and March, when fuel supplies had a severe check in consequence of transport difficulties, and they are laying in stocks as a precaution against another hard winter. Australian business, which has done so much to sustain the Northumberland coal trade over the spring and summer of this year, is still not at an end. Some thousands of tons of coal are still to be dispatched to the Antipodes, and this week there has been an inquiry for 7000 tons of steam coal for shipment next month. The cold snap has increased the home demand for gas coals, and shipments are on a large scale. Tonnage is coming to hand very well, and there are full stems for a week or two ahead. All grades are well held at prevailing figures, favourite brands commanding 16s. 9d., and specials 17s. to 17s. 6d., while secondary descriptions are steadier at 15s. to 15s. 6d. Coking coal is steadily recovering from dulness, and up to 16s. is asked for good qualities. There are reported to have been large sales at 15s. 7½d., and more business is coming on. Belgian undertakings, for example, are inquiring for considerable quantities. Best bunkers are a shade firmer, but the ordinary classes are easy at late figures. A slightly easier tendency is noted in blast-furnace coke, although the price is little altered. Gas coke fully upholds late strength, as supplies are practically off the market for this month, and there is not much offering for next month. Patent foundry cokes are able to keep to late figures without much effort. There is a steady flow of shipment orders, and home requirements are considerable.

SCOTLAND.

(From our own Correspondent.)

Conditions Unchanged.

GENERAL conditions in the steel, iron and coal trades remain unchanged. Outputs are more or less maintained, but only in a small number of cases are plants working at anything approaching full capacity. Prospects of higher steel prices induced some buying last week, but this movement has been curbed by the Association's decision to make no change meantime. Some fair shipbuilding and railway contracts are reported or are in prospect, which may improve matters for a time, but on the whole business is not being offered in sufficient quantity to promise definite or lasting improvement.

Steel.

Makers of heavy steel have only immediate commitments at the moment, and the state of inquiry is not too promising. A fair demand exists for structural and railway material, and the latter is expected to improve in view of the agreement between the Argentine Republic and Lord d'Abernon's Commission.

Steel Sheets.

The position of the sheet trade can be said to have improved considerably since the summer months. Galvanised descriptions, however, still show decided weakness, and prices are still falling, the home quotation being now about £13 2s. 6d., and export £12 17s. 6d. per ton for 24 gauge.

Tubes.

Tube makers are still comparatively well placed. The production is being maintained and easily disposed of, though the export demand for small sizes has fallen off somewhat.

Iron.

There is practically no change in the bar iron trade. Makers are hopeful of participation in the expected railway contracts, but in all probability will find a stern competitor in steel owing to the cheaper cost of the latter. Re-rolled steel bars are very quiet meantime and experience keen competition for any business offered. Re-rolled steel bars are quoted £7 15s. per ton, home or export.

Pig Iron.

The production of pig iron is still limited to about twenty furnaces, but the output is ample to meet all present requirements. Prices continue on the agreed basis of 80s. per ton hematite, 78s. 6d. No. 1 foundry, and 76s. per ton No. 3 foundry.

Scrap.

Supplies of scrap have become more plentiful, and in view of foreign imports consumers have been inclined to restrict deliveries, consequently prices are still disposed to weaken, although they are still on last week's level of 72s. 6d. for heavy steel, and 70s. per ton for heavy basic with cast iron machinery scrap.

Coal.

The position in the coal trade shows little change. Fifeshire steams remain on a very firm basis, in spite of irregular arrivals of steamers interfering with loading operations. Lothian steams are moving freely, but are fairly easily obtained for prompt shipment at about current rates. Lanarkshire splints feel the lack of Italian orders and might be secured somewhat below quoted prices. Ells have, on the other hand, improved with a better home demand. In all districts washed materials are a very firm feature. Aggregate shipments amounted to 304,451 tons, against 308,301 tons in the preceding week, and 230,524 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE has been no pronounced alteration in the general state of the steam coal trade during the past week. The inquiry continues rather on the quiet side, and yet shipments undoubtedly maintain a good level. They have not been quite as good recently for the simple reason that bad weather has caused delays to tonnage and interfered with work generally at the loading and discharging ports. This, of course, has dislocated the arrangements of many collieries, and stimulated the demand for prompt tonnage, but since the end of last week the situation has improved, and on Tuesday of this week the reports from the docks showed that whereas there were only nine idle tipping appliances there were about twenty steamers waiting to berth, though it should be pointed out that the bulk of these were at Swansea and Port Talbot, where the pressure for anthracite coals continues without marked diminution. The feature of steam coals is the sustained demand for France, which is attributed to the falling off in the production at French mines as a consequence of labour supplies being reduced, while it is also stated that one of the reasons why steamers are getting longer turns in discharging at French ports is that labour is short. Whether this is altogether the case, the fact remains that business in coals from this district for the near continental ports is good, and promises to continue to be active. The inquiry from other directions leaves much to be desired, and this is reflected in the very moderate demand for tonnage, though there are some indications of the conditions displaying a slightly better tendency. It is reported that the Dutch State Railways and the Norwegian State Railways are in the market for supplies of steam coals, but it is not expected that much, if any, of this business will come to this district.

The Government Proposals.

The Government's proposals for dealing with the coal industry generally came up for consideration by the Executive of the South Wales Miners' Federation on Saturday last, and this was followed on Monday by a special delegate conference of the coalfield. As was generally expected, the conference voted overwhelmingly in favour of the Government scheme. The actual voting was 175,000 in favour and 6000 against, so that there was a majority of 169,000. On the same day traders interested in the exportation of coal and allied interests in this district met under the auspices of the Cardiff Chamber of Commerce, and unanimously passed a resolution viewing with alarm the proposed interference of the Government with the coal trade, with its inevitable serious consequences to the export trade, the interests of the railwaymen, dock workers, ship repairers, &c. The resolution described it as imperative that there should be an early solution of the present difficulties. It was decided that copies of the resolution should be sent to the Prime Minister, the President of the Board of Trade, the Lord Privy Seal, the Minister of Mines, and the three Members of Parliament for Cardiff.

The Latest Coal Combine.

Reference was made last week to the negotiations concerning the proposed combine affecting the colliery interests of Guest, Keen and Nettlefolds, Ltd., in so far as their Abercynon Collieries are concerned, the Cambrian group and other undertakings, including that of Gueret, Llewellyn and Merrett, Ltd. Since then official details of the scheme have been made public in a circular signed by Mr. T. J. Callaghan, chairman, and Mr. H. H. Merrett, managing director, of Gueret, Llewellyn and Merrett. It is proposed to form a company with a capital of 8½ millions, divided into 3½ million in 7½ per cent. cumulative preference shares and 5¼ millions in ordinary shares. The basis of the consideration in the matter of exchange of shares into the new company—other than the Cambrian group—is to be 12s. 6d. per ton on the potential outputs of the collieries. In the case of the Cambrian group of collieries the consideration payable to Guest, Keen and Nettlefolds, Ltd., is £1,000,000, of which £225,000 is to be satisfied by allotment of ordinary shares in the new company and the remaining £775,000 in debentures at a rate of interest not exceeding 7 per cent. These debentures will be part of a proposed issue of £2,000,000. In the case of Gueret, Llewellyn and Merrett, Ltd., the preference shareholders are offered one 7½ per cent. preference share in the new company for each of their existing 7 per cent. preference shares, plus the payment of the four and a-half years' arrears of dividend, while the ordinary shareholders are offered 34s. 6d. per share for each share of their present holdings, which is to be satisfied by the allotment of shares in the new company on the basis of one-third of a preference share and two-thirds of an ordinary share for every £1 value involved. These terms have been accepted by the majority of the ordinary shareholders in Gueret, Llewellyn and Merrett, Ltd. If in the case of the other companies acceptances of the terms represent less than 90 per cent. of the issued capitals of such companies, it is optional on the new company to take or reject the shares offered, and to proceed with the scheme in the case of those companies whose acceptances exceed 90 per cent.

Coal Conveyors.

Last week Sir Alfred Cope, the managing director of Amalgamated Anthracite Collieries, Ld., Mr. Chubb Jones, President of the Swansea Chamber of Commerce, and Mr. R. D. Roberts, the local superintendent of the L.M.S. Railway, visited Ellesmere Port, Manchester, for the purpose of inspecting the coal-shipping appliances, especially the belt conveyor arrangements. The opinion formed, according to one of the party, is that the details of the method of loading at Ellesmere would not be applicable to Swansea, but they saw what could be done with the belt conveyors, which the L.M.S. Railway Company proposes to install on its two tips at the Prince of Wales Dock at Swansea, and with the modifications which they have suggested to the company it should reduce breakages to a minimum.

Iron and Steel Matters.

Last week-end the Bryngwyn Steel Works, Grovesend, closed down for a month or five weeks while improvements to machinery are carried out. About 600 workmen are, as a consequence, idle. The Joint Standing Committee of the South Wales Siemens Steel Trade Conciliation Board met last week to consider new wage claims at individual works, but it was eventually agreed to refer them to sub-committees. It is reported that 650 members of the Iron and Steel Trades Confederation at the Mannesmann Mill Works, Landore, Swansea, have seceded from that body and joined the National Union of General and Municipal Workers, owing to their dissatisfaction with recent negotiations, their complaint being that only the higher-paid workers benefited. A notice has been issued by the employers in which they state that they will not recognise the new union.

Distress.

The conditions in many parts of South Wales, especially Porth, Trehavod, and Neath Abbey, arising from the heavy rains, causing landslides, the flooding of houses and destruction of property, are really terrible. Whole families have been compelled to evacuate their homes, and hundreds of men are unable to follow their occupations.

Current Business.

The general tone of the steam coal market is quiet, but collieries are better employed as a whole than was the case a week ago. Dry large coals are especially in demand, and are firm, but most of the other qualities can be obtained without difficulty at minimum prices. The market for smalls and sized coals keeps good, and patent fuel makers are well stemmed for the next week or two. Coke finds a ready outlet. Pitwood is steady at about 28s. 6d. to 29s.

CONTRACTS.

GUEST AND CHRIMES, Ltd., of Rotherham, recently received from the Metropolitan Water Board an order for the supply of their "Planet" positive water meters.

UNITED WATER SOFTENERS, Ltd., have recently received orders from twenty-one separate customers for water treatment plants of various types for dealing in the aggregate with some 5¾ million gallons of water per day.

SULZER BROS., of 31, Bedford-square, London, W.C. 1, inform us that the Stoomvaart Maatschappij Nederland, of Amsterdam, has just placed an order for a Sulzer double-acting two-stroke marine oil engine of 7000 S.H.P. The engine will run at a designed speed of 106 r.p.m., and it will have eight cylinders, each with a diameter of 700 mm., or 27 $\frac{9}{16}$ in. The engine will be installed in a new single-screw motor vessel.

J. W. BROOKE AND CO., Ltd., of Lowestoft, received a short time ago an order for thirty-three fast motor boats for the Rio Bay Customs service of the Brazilian Government. Three of the boats are 44ft. fast cruisers, while the remaining thirty are 30ft. cabin cruisers. In both types of craft six-cylinder "Brooke Hundred" engines will be employed. Twenty-two of the boats have already been laid down and thirteen have undergone successful trials.

INTERNATIONAL COMBUSTION, Ltd., asks us to announce that its associated company, International Combustion Engineering Corporation, of America, has received from the Ford Company an order for two double Ladd boilers, 700,000 lb. each actual maximum evaporation, 1400 lb. pressure, 750 deg. Fah. superheat, and also a further order for two boilers of 300,000 lb. maximum evaporation at 1400 lb. pressure and 750 deg. Fah. superheat for Milwaukee.

ROYCE LTD., of Trafford Park, Manchester, have recently received orders for (*a*) eight 10-ton overhead travelling cranes for a large new motor works; (*b*) twelve overhead travelling cranes, ranging from 1½ tons to 40 tons capacity, for use in paper mills; (*c*) two 10-ton overhead travelling cranes for an engineering works; (*d*) two pulp stacking cranes for paper mills; one 5-ton overhead travelling crane for a glass works; and one 7½-ton overhead travelling crane for an iron and pipe works. During the month of October the same firm shipped abroad two 5-ton cranes for Constantinople; two 10-ton cranes for India (one of 96ft. span); one 15-ton crane, one 5-ton crane and one Goliath crane, also for India; and one 10-ton crane for South Africa.

MIRRLEES, BICKERTON AND DAY, Ltd., have recently received orders for Diesel engines from:—The Madras and Southern Mahratta Railway Company (1); the Port Commissioners, Calcutta (1); India General Navigation and Railway Company (1); Dabhoi Electricity Supply Company, Ltd. (1); Callender's Cable and Construction Company, Ltd., for Persia (2); City of Hamilton Waterworks (1); Rosthern Wynyard (2); town of Unity (1); Melford, Saskatchewan (1); Humboldt (1); Panama Corporation (3). The same company has also received an order for three 75 B.H.P. engines, each driving a vertical-spindle high-lift pump; three 480 B.H.P. engines, each driving through gearing a Hathorn-Davey reciprocating pump and two 75 B.H.P. engines, each coupled to a Brush dynamo for lighting.

PUMP CALCULATOR.—A convenient calculator for solving pumping problems has been sent to us by Gwynnes Pumps, Ltd., of Hammersmith. It is made of card and is, when folded, post-card size. It enables the user to obtain almost at a glance the frictional head for pumps and their appropriate piping and connections. By adding the static head to the frictional head the total head is at once obtained.

THE IRON AND STEEL INSTITUTE.—The Williams Prize of the Iron and Steel Institute, of the value of 100 guineas, has this year been awarded by the Council to Mr. William E. Simons, assistant blast-furnace manager at the Cardiff works of Guest, Keen and Nettlefolds, Ltd., in consideration of his paper on "The A.I.B. Sinter Plant at the Works of Guest, Keen and Nettlefolds, Ltd.," which he presented at the last annual meeting of the Institute in London.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
(1) Native	19/6 to 22/-
(1) Spanish	24/- to 26/-
(1) N. African	24/- to 26/-
N.E. Coast—	
Native	18/- to 21/-
Foreign (c.i.f.)	24/9

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	4 0 0	—
No. 1 Foundry	3 18 6	—
No. 3 Foundry	3 16 0	—
N.E. Coast—		
Hematite Mixed Nos.	3 18 0	3 18 0
No. 1	3 18 6	3 18 6
Cleveland—		
No. 1	3 15 0	3 15 0
Silicious Iron	3 15 0	3 15 0
No. 3 G.M.B.	3 12 6	3 12 6
No. 4 Foundry	3 11 6	3 11 6
No. 4 Forge	3 11 0	3 11 0
Mottled	3 10 6	3 10 6
White	3 10 6	3 10 6
Midlands—		
(3) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	—	—
„ „ Foundry	—	—
(3) Northampton—		
Foundry No. 3	3 15 0	—
Forge	3 11 0	—
(1) Derbyshire—		
No. 3 Foundry	3 18 6	—
Forge	3 14 6	—
(3) Lincolnshire—		
No. 3 Foundry	3 13 6	—
No. 4 Forge	3 9 6	—
Basic	—	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 7 6 (*a*); 4 9 6 (*b*); 4 13 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. Coast—		
Iron Rivets	11 10 0	—
Common Bars	10 15 0	—
Best Bars	11 5 0	—
Double Best Bars	11 15 0	—
Treble Best Bars	12 5 0	—
Lancs.—		
Crown Bars	10 15 0	—
Second Quality Bars	9 15 0	—
Hoops	13 0 0	—
Yorks.—		
Crown Bars	11 0 0	—
Best Bars	11 10 0	—
Hoops	12 0 0	—
Midlands—		
Crown Bars	10 0 0 to 10 10 0	—
Marked Bars (Staffs.)	12 10 0	—
Nut and Bolt Bars	9 0 0 to 9 5 0	—
Gas Tube Strip	11 2 6	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 0 0	10 0 0
Ship Plates, ½in. and up	8 7 6	7 12 6
Sections	8 2 6	7 2 6
Steel Sheets, ¼in.	9 0 0	8 15 0
Sheets (Gal. Cor. 24 B.G.)	12 17 6	12 17 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	8 12 6	—
Angles	8 2 6	—
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 2 6	—
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 10 0	—
Light Rails	8 15 0 to 9 0 0	—
Billets	6 15 0 to 9 10 0	—
Manchester—		
Bars (Round)	9 2 6	—
„ (Small Round)	8 5 0 to 8 7 6	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	10 0 0	—
Sheffield—		
Siemens Acid Billets	9 10 0	—
Hard Basic	9 2 6 and 9 12 6	—
Intermediate Basic	7 12 6 and 8 2 6	—
Soft Basic	7 0 0	—
Hoops	9 15 0 to 10 5 0	—
Soft Wire Rods	8 2 6	—
Midlands—		
Small Rolled Bars	8 2 6 to 8 15 0	—
Billets and Sheet Bars	6 5 0 to 6 12 6	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	—
Galv. Sheets, f.o.b. L'pool	12 15 0 to 13 0 0	—
Angles	8 2 6	—
Joists	8 2 6	—
Tees	9 2 6	—
Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 12 6	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	18/9 to 19/-
Block Tin (cash)	179 7 6
„ (three months)	182 0 0
Copper (cash)	70 0 0
„ (three months)	69 2 6
Spanish Lead (cash)	21 15 0
„ „ (three months)	21 15 0
Spelter (cash)	21 13 9
„ (three months)	22 2 6
Manchester—	
Copper, Best Selected Ingots	76 10 0
„ Electrolytic	83 15 0
„ Strong Sheets	110 0 0
„ Tubes (Basis Price), lb.	0 1 3
Brass Tubes (Basis Price), lb.	0 1 1
„ Condenser, lb.	0 1 3
Lead, English	22 17 6
„ Foreign	21 10 0
Spelter	21 7 6
Aluminium (per ton—raw ingot)	£95

FERRO ALLOYS.

	Per Ton.	Per Unit
Tungsten Metal Powder	3/6½ per lb.	
Ferro Tungsten	3/3½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	7/6
„ „ 6 p.c. to 8 p.c.	£22 0 0	6/6
„ „ 8 p.c. to 10 p.c.	£21 17 6	6/-
„ „ Specially refined		
„ „ Max. 2 p.c. carbon	£33 0 0	10/-
„ „ „ 1 p.c. carbon	£38 0 0	15/-
„ „ „ 0·70 p.c. carbon	£39 0 0	15/-
„ „ „ carbon free	1/2 per lb.	
Metallic Chromium	2/6 per lb.	
Ferro Manganese (per ton)	£13 15 0 for home; £13 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 0 0 scale 7/- per unit	
„ Vanadium	12/10 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£170 to £175	
Ferro Cobalt	9/4 per lb.	

FUELS.

SCOTLAND.

(*Prices not stable.*)

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	14/-
„ „ Ell	16/6
„ „ Splint	16/6 to 18/-
„ „ Trebles	17/-
„ „ Doubles	16/- to 16/6
„ „ Singles	14/- to 14/6
Ayrshire—	
(f.o.b. Ports)—Steam	14/6
„ „ Jewel	16/6
„ „ Trebles	17/6
Fifeshire—	
f.o.b. Methil or Burntisland—Steam	14/- to 16/-
Screened Navigation	17/6 to 18/6
Trebles	18/- to 19/6
Doubles	16/- to 17/-
Singles	15/-
Lothians—	
(f.o.b. Leith)—Best Steam	14/6
Secondary Steam	13/9
Trebles	17/6
Doubles	16/-
Singles	14/-

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	21/6 to 23/-
Household	38/- to 51/-
Coke	27/6
Northumberland—	
Best Steams	16/9 to 17/-
Second Steams	15/6 to 16/-
Steam Smalls	10/- to 10/6
Unscreened	13/- to 13/6
Household	25/- to 37/-
Durham—	
Best Gas	16/6 to 16/9
Second	15/- to 15/1
Household	25/- to 37/-
Foundry Coke	25/- to 30/-
Sheffield—	
Best Hand-picked Branch	26/6 to 28/-
Derbyshire Best Bright House	21/- to 23/-
Best House Coal	20/6 to 21/6
Screened House Coal	18/6 to 20/-
„ „ Nuts	16/6 to 18/-
Yorkshire Hards	15/6 to 17/-
Derbyshire Hards	15/6 to 17/-
Rough Slacks	9/- to 10/-
Nutty Slacks	7/6 to 8/6
Smalls	3/- to 5/-
Blast-furnace Coke (Inland)	14/6 at ovens
Furnace and Foundry Coke (Export), f.o.b.	23/- to 24/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	20/- to 20/3
Second Smokeless Large	18/9 to 20/-
Best Dry Large	19/6 to 21/-
Ordinary Dry Large	19/- to 19/6
Best Black Vein Large	18/3 to 18/6
Western Valley Large	17/9 to 18/-
Best Eastern Valley Large	17/9 to 18/3
Ordinary Eastern Valley Large	17/6 to 17/9
Best Steam Smalls	14/3 to 14/6
Ordinary Smalls	13/- to 14/-
Washed Nuts	19/6 to 30/-
No. 3 Rhondda Large	20/3 to 21/-
„ „ Smalls	15/6 to 16/-
No. 2 „ Large	17/3 to 17/6
„ „ Through	15/6 to 16/6
„ „ Smalls	14/3 to 14/9
Foundry Coke (Export)	32/6 to 37/6
Furnace Coke (Export)	30/- to 31/-
Patent Fuel	22/- to 22/6
Pitwood (ex ship)	28/9 to 29/3
Swansea—	
Anthracite Coals:	
Best Big Vein Large	35/- to 37/6
Seconds	28/6 to 30/6
Red Vein	24/- to 27/6
Machine-made Cobbles	42/- to 45/-
Nuts	42/6 to 45/-
Beans	25/- to 27/-
Peas	19/3 to 19/9
Breaker Duff	10/3 to 10/6
Rubbly Culm	13/3 to 13/9
Steam Coals:	
Large	18/- to 19/-
Seconds	17/- to 18/-
Smalls	12/- to 13/9
Cargo Through	15/6 to 16/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate: Joists (minimum), 12/6; Ordinary Ship, Bridge and Tank Plates and Sections, 10/- if home consumers confine purchases from associated British Steel Makers.

French Engineering Notes.

(From our Correspondent in Paris.)

Commercial Vehicles.

SINCE the railways began to run services of motor vehicles, and the road transport companies set themselves out to compete with the railways, there has been a great increase in speed and paying loads, and at the Show held in the Grand Palais, Paris, the lorry and omnibus chassis followed still more closely the lines of the touring car. A number of them had six-cylinder engines, forming one unit, with the gear-box, and the chassis were more rationally designed in accordance with touring car practice than was the case when makers were at variance as to whether the commercial vehicle should be built on distinctive lines of its own. So far as the general arrangement is concerned, there does not seem likely to be much change, but the introduction of the heavy-oil engine of the injection type points to important developments in this direction. Until recently Peugeot was practically alone in this country with the two-cycle heavy-oil engine on the Junkers system, but Renault now builds a chassis with engine of the so-called Diesel type, and Saurer and two or three other makers had vehicles fitted with heavy-oil engines. What attracted most interest was the Mercédès-Benz chassis with a six-cylinder Diesel engine. The frame was exceptionally long, the total length being approximately 30ft. It was mounted on three axles, two of them drivers, with the same propeller shaft. A similar arrangement of transmission gear was seen on the Miesse lorry. So far, the vehicle running on heavy oils has made slow progress on account, principally, of the difficulties experienced by users, but there is reason to believe that those difficulties are being overcome. Meanwhile the charcoal suction gas plant holds its own, and Panhard, Renault, and other firms showed lorries running on that fuel. For the moment its main field of utility appears to lie in the African Colonies. One of the Panhard lorries has travelled some thousands of miles in Central Africa.

Charcoal Suction Gas.

One difficulty in the way of the more general use of suction gas vehicles is the uncertainty of always being able to procure ample supplies of cheap charcoal. At a congress on charcoal held at Lyons it was stated that the woods and forests in France were capable of producing 1,200,000 tons of charcoal a year. At present the production is about one-third of that amount. The State regards this source of fuel supply as so important that a considerable sum of money has just been devoted to afforestation and to the purchase of forests. It was declared at the congress that the fitting of any kind of suction gas plant to a vehicle with a petrol engine reduced the power and deprived the fuel of much of its economy; but now that manufacturers are building suction gas lorries with engines adapted to that fuel the difference in power was too small to affect the economy of suction gas. The conclusion of the reports presented at the congress was that the country was capable of producing a sufficient quantity of fuel for the needs of motor lorries, and reference was also made to the injection of pulverised charcoal in internal combustion engines, this being regarded as a line of research which was capable of producing interesting results from the point of view of national economy.

Naval Construction.

In the preamble to the Bill authorising the putting in hand of another instalment of the programme of naval construction in the coming year it is stated that the French Navy has still in service 350,000 tons of pre-war vessels and 50,000 tons of ships surrendered by the Germans. These will have to be replaced within a period of ten years. Owing to the increasing cost of construction it is intended to build 48,000 tons in 1930 instead of the average of 53,400 tons which are necessary to keep up the strength imposed by the Naval Statute. The ships to be put on the stocks will comprise one 10,000-ton cruiser, six destroyers of somewhat greater displacement than the previous ones, six first-class submarines, one submarine minelayer, one surface minelayer, one net layer, and two "-avisos" for colonial and foreign service. The net layer has been evolved after long experiments at Toulon as a protection for ships in port. The expenditure involved in the building of these ships is 1267 million francs. Meanwhile, more men are being attracted to the navy by the special advantages offered them, and during the week the Minister of Marine laid the foundation stone of a training school at Brest. Since the "Borda" was withdrawn from service the youths have been trained ashore, and this will be continued in the school now being built.

Aviation.

Since the creation of the Air Ministry the work of reorganising the air services has been making rapid progress, and it has now reached a stage when it is hoped to demonstrate that the French industry has retrieved its former position. The Air Minister believes that this may be done in the coming year. He has invited tenders from four makers for the supply of suitable machines to cross the Atlantic. One maker has already under construction a huge seaplane with four engines developing altogether 2000 horse-power, there being two tractor engines, each of 600 horse-power, and two engines behind each of 400 horse-power. Another aeroplane has just been completed at the works at Bordeaux formerly belonging to the Ateliers Dyle et Bacalan and now acquired by a new company which has been formed under the title of the Société Aérienne Bordelaise. It is a monoplane intended to carry twenty-eight passengers. A central frame built up of high-tensile steel sections supports the wings and two fuselages. This frame constitutes a spacious saloon for the passengers. There are three tractor propellers driven by Hispano-Suiza engines, each of 600 horse-power with reduction gearing. The total span is 120ft. and the length 70ft. The machine has a supporting surface of 2000 square feet. It weighs without fuel 7½ tons and will carry a paying load of 3 tons. The preliminary flying tests have been quite satisfactory. These huge machines are intended for the services to Indo-China and Madagascar and more particularly for the service between Dakar and Brazil.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

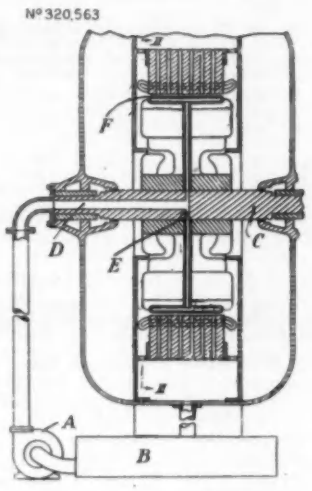
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

DYNAMOS AND MOTORS.

320,563. December 1st, 1928.—DYNAMO-ELECTRIC MACHINES, Frank George Baum, of 1901-2, Hobart Building, San Francisco, California.

A dynamo-electric machine constructed in accordance with this invention is cooled with oil. A circulating pump A is furnished with a suction pipe connected to the reservoir B. The shaft C is provided with a passageway or duct D extending from

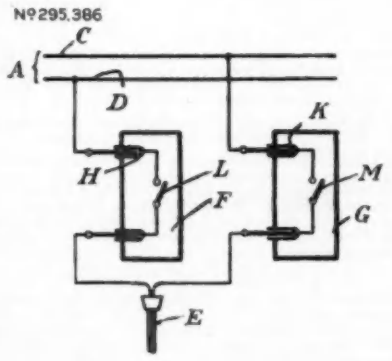


one end to a point within the hub of the rotor and connection is made at that point by radial ducts E, extending toward the surface of the rotor. At the rotor surface and between the salient poles there are liquid receptacles forming spray heads F, and are connected to the radial channels E, the channel D, and the pump A. Provision may likewise be made for the passage of small currents of gas through the rim of the rotor by any convenient means.—*October 17th*, 1929.

SWITCHGEAR.

295,386. August 2nd, 1928.—ELECTRIC-DISTRIBUTING SYSTEMS WITH DUPLICATE BUS-BARS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt.

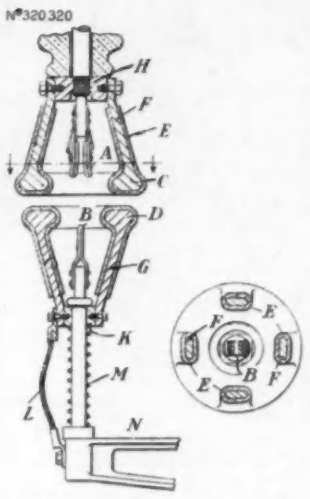
As is well known, switching installations are operated with duplicate bus-bar systems, so that only one bus-bar system is used for working purposes, the other being kept in reserve. The present invention renders switching over possible without any interruption of the working with relatively simple means.



In the diagram A indicates the duplicate bus-bar system, with the individual bus-bars C and D, whilst E is an incoming or outgoing conductor, which branches off in two parts. In each part there is a switch carriage F and G, which can be withdrawn, and each carriage contains an oil switch L and M respectively. For switching over, it is unnecessary to withdraw the carriage, as in each separate branch an oil switch is provided; consequently no interruption of the working occurs upon switching over.—*October 17th*, 1929.

320,320. June 8th, 1928.—ELECTRIC CIRCUIT BREAKERS, Edmund Basil Wedmore, Willis Bevan Whitney, and the British Electrical and Allied Industries Research Association, of 36 and 38, Kingsway, London, W.C. 2.

This invention relates to improvements in circuit breakers for use in circuits carrying electric power, and is particularly applicable to circuits wherein the electrical pressure is relatively high, say, of the order of 10,000 or more line volts. The upper contact A is fixed and the lower or male contact B is movable, and is carried by a cross bar N at the other end of which there is another similar movable contact, to be associated with a fixed contact for a double-break circuit breaker. Surrounding the two contacts A and B are shields C and D, respectively, each covered with insulating material as indicated at E. The shields are in the form of rings supported by arms F and G. The arms F are bolted to a collar H, fixed in electrical connection with the contact A. The arms G are bolted to a collar K, which is a sliding fit on the movable contact B, and is maintained in good electrical connection with that contact by means of a conducting strip L. It will be seen that the ring C is retained at a position beyond the extremity of its associated contact A, and when the contacts are open, as shown, the shield D is retained in a similar manner beyond the end of its contact B by means of a coiled compression spring M. When the contacts are to be closed, however, the insulation covering the shield D makes contact with that covering the shield C, so that the shield D is pressed

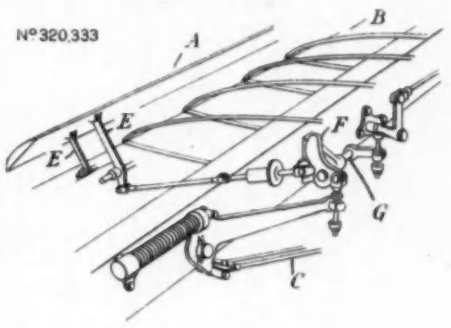


back against the spring M to permit the contact B to enter the contact A.—*October 8th*, 1929.

AERONAUTICS.

320,333. May 3rd, 1929.—SLOTTED WINGS, C. R. Fairey, Cranford-lane, Hayes, Middlesex.

This invention is concerned with the construction of "slotted wing" aeroplanes, with the object of preventing the structure of the machine being misabused in the event of a sudden dive or some such manœuvre. The ordinary control of the auxiliary wing A, which forms the "slot" in conjunction with the main

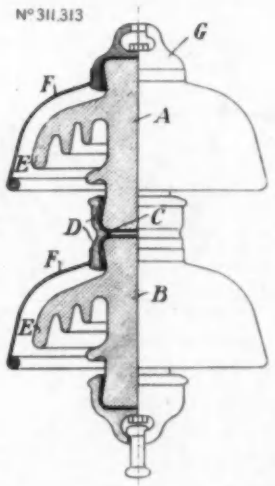


wing B, is effected by the manual control wires C, the bell crank and the parallel links E E, through the intervention of the bell crank F. This bell crank is mounted on a spindle G, which, by means of another bell crank system, is connected with a plane that responds to the immediate flying conditions. There is sufficient backlash in the various connections to permit the usual manual control, but in the event of abnormal circumstances the automatic control becomes effective.—*October 3rd*, 1929.

TRANSMISSION OF POWER.

311,313. December 14th, 1928.—ELECTRIC INSULATORS, Brown, Boveri et Cie., A.G., of Mannheim, Germany.

According to this invention atmospheric influences are kept away from the porcelain body of the insulator by surrounding the essential parts by a metal screen. In the drawing A and B are two bar insulators connected together by a sleeve C, which is provided with a short collar-like projection D, acting as a



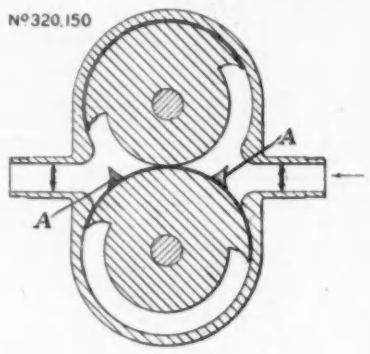
thrust bearing for the end surfaces of the corresponding ends of the insulators. For protecting the insulators and the screen E a metal screen F is secured to the metal cap G and to the connecting sleeve D. The metal screen completely surrounds the screen E and also the shaft, and thus secure protection against atmospheric influences, so that the insulating portion of the insulator may remain in a good condition.—*October 17th*, 1929.

PUMPING AND BLOWING MACHINERY.

320,150. January 22nd, 1929.—ROTARY PUMPS, T. B. Othen, 54, Snowdon, Chard, Somerset.

The general construction of this pump needs little comment

as its mode of operation is obvious. It is, however, noteworthy that the inventor claims for the deflectors A A that they eliminate pulsations in the delivery. He also claims for the coating

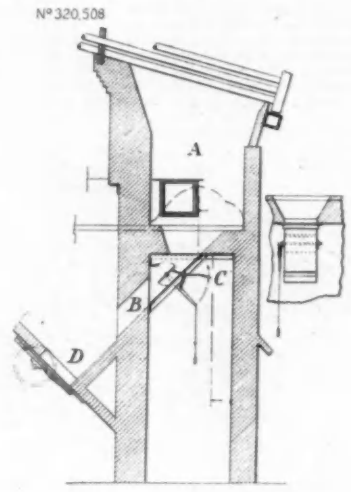


of the rotors with lead, or a lead alloy, to check corrosion.—*October* 10*th*, 1929.

FURNACES.

320,508. September 24th, 1928.—Boiler Furnaces, The Gas Light and Coke Company, 84, Horseferry-road, Westminster; P. Gray and W. G. Adam, The Tar and Ammonia Products Works, Beeton.

The inventors propose to remove the dust from boiler flue gases, on their way from the furnace to the boiler proper, with

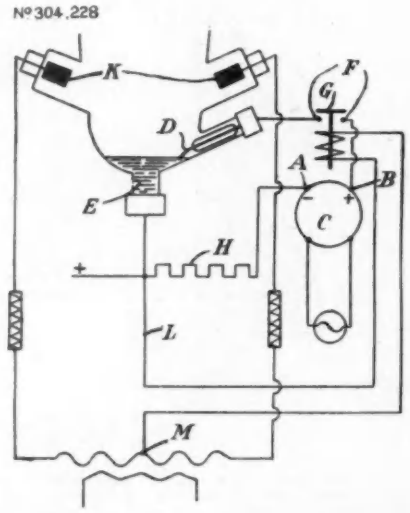


the object of keeping the water tubes as clean as possible. This is effected by allowing the dust to settle in the chamber A. The dust is periodically discharged down the shoot B by opening the damper C, and is caught in the hopper D from which it may be drawn off into trucks after it has cooled.—*October* 17*th*, 1929.

MISCELLANEOUS.

304,228. November 16th, 1928.—Mercury Vapour Apparatus, *Hewittic Société Anonyme, of* 11, *rue du Pont, Suresnes* (*Seine*), *France*.

According to this invention, a unidirectional current-carrying device is interposed in the circuit of the auxiliary or starting electrode of a mercury rectifier so that, when energised, the auxiliary electrode is always positive with respect to the cathode. Unidirectional current is supplied from the terminals A B of the rectifying device C to the starting circuit, comprising the auxiliary



electrode D, the cathode E, the contacts F, and contact member G of the relay and the resistance H and causes an arc to be struck between the cathode E and the excitation anodes K, with the result that unidirectional current flows through the conductor L and the coil M of the relay, energising the latter, which then operates to break the starting circuit at the contacts F. The rectifying device C may be of any type, but preferably of simple construction, and may be constituted, for example, of oxidised copper discs.—*October* 10*th*, 1929.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Royal Aeronautical Society: Postponed Lecture.—The lecture by Senr. de la Cierva on "Recent Work on the Autogiro," originally fixed for December 5th next, has been unavoidably postponed. The lecture will be delivered by Senr. de la Cierva in the second half of the present Session.

TO-DAY.

Institution of Automobile Engineers: Coventry Centre.—King's Head Hotel, Coventry. Annual dinner. 7.30 p.m. for 8 p.m.

Institution of Engineering Inspection.—At the Rooms of the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. "Saws: Their Manufacture and some Hints on their Use," illustrated by lantern slides and exhibits, by Mr. T. W. Willis. 5.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Informal meeting. "The Utilisation of Low-grade and Refuse Fuels, including Towns' Refuse," to be introduced by Mr. J. S. Atkinson. 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Ordinary meeting. "The Quick-running Oil Engine as applied and used in Railway Service," by Mr. H. D. Bush. Slides. 7.30 p.m.

Physical Society.—At the Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. "Heaviside's Operational Method," by Mr. D. P. Dalzell; "The Dynamical Theory of Resonators," by Mr. E. T. Hanson; "Escapement Errors of Pendulum Clocks," by Mr. E. C. Atkinson. 5 p.m. Editing Committee meeting, 3.30 p.m.; Council meeting, 4 p.m.

TO-DAY and SATURDAY, NOVEMBER 23rd.

Public Works, Roads and Transport Congress and Exhibition (1929).—Royal Agricultural Hall, London, N. For programme of Congress, see page 422.

SATURDAY, NOVEMBER 23rd.

Institution of Civil Engineers.—Students' Visit, Saturday (Morning), to the London General Omnibus Company's Works, Chiswick.

MONDAY, NOVEMBER 25th.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. "The Mercédès-Benz Diesel Engine," by Mr. W. H. Goddard. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Musical and Scientific Aspects of Wind Instruments." Lecture II: How the air is set in vibration in a flute and flue pipe. The formation of eddies. Edge-tones and their importance in the functioning of the flute. How a reed sets the air in vibration. The function of mouth pieces of brass instruments. By Dr. E. G. Richardson. 8 p.m.

TUESDAY, NOVEMBER 26th.

Institute of Marine Engineers.—85-88, The Minories, London, E.C. 3. "The Origin and Development of Heavy Oil Engines" (Akroyd Stuart Award Prize Paper, 1929, Abridged), by Mr. A. F. Evans. 6.30 p.m.

Institute of Metals: Birmingham Local Section.—In the Chamber of Commerce, New-street. "The Modern Development of the Steam Locomotive," by Mr. G. W. Woolliscroft. The paper forms part of a joint programme arranged by the Birmingham Metallurgical Society, the Staffordshire Iron and Steel Institute, and the Birmingham Local Section of the Institute of Metals. 7 p.m.

Institution of Automobile Engineers: Western Graduates.—Canteen at the works of the Bristol Tramways and Carriage Company, Ltd., Brislington, Bristol. "Braking Topics," by Mr. E. W. Sisman. 7.30 p.m.

Institution of Electrical Engineers: North Midland Centre.—The Hotel Metropole, Leeds. "Surges and Overvoltage Phenomena on Transmission Lines Due to Lighting and Switching Disturbances," by Dr. H. Norinder. 7 p.m.

Institution of Electrical Engineers: Scottish Centre.—The Grosvenor Restaurant, Gordon-street, Glasgow. Annual dinner and ladies' evening.

Manchester Association of Engineers.—Joint meeting at the invitation of the North-Western Centre of the Institution of Electrical Engineers. Engineers' Club, Albert-square, Manchester. "The Heating of Buildings Electrically by Means of Thermal Storage," by Mr. S. E. Monkhouse and Mr. L. C. Grant. Discussion follows. 7 p.m.

WEDNESDAY, NOVEMBER 27th.

Institute of Physics.—In the Rooms of the Institution of Electrical Engineers, Savoy-place, Victoria Embankment, London, W.C. 2. Public Lectures on Physics in Industry. No. 15, "Physics in relation to the Utilisation of Fuel," by Dr. C. H. Lander. 5.30 p.m.

Institution of Automobile Engineers: North of England Centre.—Engineers' Club, Albert-square, Manchester. "The High-speed Compression-ignition Heavy-oil Engine," by Mr. F. R. Banks. 7 p.m.

Institution of Chemical Engineers.—In the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W. 1. "Production and Treatment of Cellulose in the Paper Industry." by Mr. James Strachan. 8 p.m.

Institution of Municipal and County Engineers: North-Western District.—In the Manchester Town Hall (Lloyd-street entrance). The meeting is to take the form of "Parliamentary Bill Proceedings," and will be run on similar lines to the special meetings of last Session. 6 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Dr. Mann Lecture, "The Examination of Coal and Coke by X-rays," by Mr. C. Norman Kemp. 8 p.m.

THURSDAY, NOVEMBER 28th.

Institution of Automobile Engineers: Luton Graduates.—Royal Hotel, Mill-street, Luton. "The Automobile Compression Ignition Engine," by Mr. S. W. Dixon. 7.30 p.m.

Institution of Automobile Engineers.—Y.M.C.A. Dining Hall, Blackett-street, Newcastle-on-Tyne. "The Pneumatic Tire in Heavy Transport," by Mr. A. Healey. 8 p.m.

The Institution of Civil Engineers: Birmingham and District Association.—In the Chamber of Commerce, New-street, Birmingham. "Renewal and Strengthening of Railway Bridges," by Mr. J. W. F. Gardner, M. Inst. C.E. 6 p.m.

Institution of Electrical Engineers.—In the Lecture Theatre of the Institution, Savoy-place, Victoria Embankment, W.C. 2. "Voltage Control of Large Alternators," by Mr. H. W. Taylor. 6 p.m.

Institution of Locomotive Engineers.—Denison House, 296, Vauxhall Bridge-road, Westminster, London, S.W. 1. "Water-tube Boilers Suitable for Locomotives," by Mr. K. W. Williams. The paper to be illustrated with lantern slides. 6 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Bolbec Hall, Newcastle-upon-Tyne. "Wake," by Mr. G. S. Baker. 6 p.m.

FRIDAY, NOVEMBER 29th.

Institution of Automobile Engineers: Scottish Graduates.—Regent Restaurant, 51, West Regent-street, Glasgow. "Two-stroke Engines: Some Experiments on a New Type," by Mr. J. W. Robertson. 8 p.m.

Institute of Marine Engineers.—At the Hotel Victoria, Northumberland-avenue, W.C. 2. Annual conversazione. Reception, 7 to 7.30 p.m.

Institution of Mechanical Engineers.—Storey's-gate, St. James's Park, London, S.W. 1. Extra general meeting. An open debate on "The Registration of Reliable Tests of Power Plant Machinery," to be introduced by Mr. R. H. Parsons. 6 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Informal meeting. Lecture, "Modern Welding Systems and Applications," by Mr. W. C. Freeman. 7.30 p.m.

SATURDAY, NOVEMBER 30th.

Institute of Metals: Birmingham Local Section.—Queen's Hotel, Birmingham. Fourth annual dinner and ladies' night.

MONDAY, DECEMBER 2nd.

Institution of Automobile Engineers: Loughborough Graduates.—The College, Loughborough. "Carburettors and Carburation," by Mr. H. G. Nicoll. 7 p.m.

Institution of Automobile Engineers: Western Centre.—Merchant Venturers' Technical College, Bristol. "The Relative Safety of Mild and High Tensile Steel Under Alternating and Pulsating Stresses," by Dr. B. P. Haigh. 6.45 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. Cantor Lecture, "Musical and Scientific Aspects of Wind Instruments," Lecture III., by Dr. E. G. Richardson. 8 p.m.

TUESDAY, DECEMBER 3rd.

Institution of Automobile Engineers.—At the Royal Society of Arts, John-street, Adelphi, W.C. 2. "Aluminium Alloys from the User's Point of View," by Mr. J. B. Hoblyn. 7.45 p.m.

Institution of Automobile Engineers: Coventry Graduates.—Broadgate Café, Coventry. "Commercial Vehicle Engines," by Mr. P. Wheeler. 7.15 p.m.

Institution of Electrical Engineers: North-Eastern Centre.—At the Central Station Hotel, Newcastle-on-Tyne. Annual dinner and reunion. Reception, 7 p.m.; dinner, 7.15 p.m.; reunion, 9.30 p.m.

WEDNESDAY, DECEMBER 4th.

Institution of Automobile Engineers.—Metropole Hotel, King-street, Leeds. "The Pneumatic Tire in Heavy Transport," by Mr. A. Healey. 7.30 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "The Advertiser and the Disfigurement of Town and Country-side: Criticisms and Suggestions," by Mr. H. H. Peach. 8 p.m.

FRIDAY, DECEMBER 6th.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. "The Demolition of Lambeth Bridge," by Mr. A. B. Gowring. 7.30 p.m.

SATURDAY, DECEMBER 7th.

Institution of Municipal and County Engineers.—South-Western District meeting to be held at Exeter. "The Local Government Act, 1929," address by Lieut.-Col. E. J. Stead. To be followed by a discussion. 3 p.m.

TUESDAY, DECEMBER 10th.

Institution of Automobile Engineers.—King's Head Hotel, Coventry. "The Relative Safety of Mild and High-tensile Steel Under Alternating and Pulsating Stresses," by Dr. B. P. Haigh. 7.30 p.m.

WEDNESDAY, DECEMBER 11th.

Institution of Municipal and County Engineers.—Northern Ireland District meeting at the Municipal College of Technology, Belfast. A paper and discussion on "Town Planning," by Mr. R. B. Donald. 6.45 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "Overheads and other Factors Influencing Road Transport Costs from an Engineer's Viewpoint," by Major Charles Wheeler. 8 p.m.

THURSDAY, DECEMBER 12th.

Institution of Automobile Engineers.—Joint meeting with the Institution of the Rubber Industry, Grand Hotel, Birmingham. "The Mechanical Properties of Rubber," by Mr. A. Healey. 7.30 p.m.

Institution of Automobile Engineers: London Graduates.—Watergate House, Adelphi, W.C. 2. "Repairs," by Mr. C. A. Partridge. 7.25 p.m.

LAUNCHES AND TRIAL TRIPS.

Dunelmia, steamship; built by Wm. Gray and Co., Ltd., to the order of Metcalfe, Son and Co., Ltd.; dimensions, 434ft. 4in. by 54ft. 3in. by 30ft. 1in.; to carry cargo. Engines, triple-expansion, 26in., 43in., 71in. by 48in stroke; pressure, 180 lb. per square inch; constructed by the builders; trial trip, October 23rd.

Vernon City, steamship; built by Wm. Gray and Co., Ltd.; to the order of Sir William Reardon Smith and Sons, Ltd., Cardiff; dimensions, 400ft. by 54ft. 3in. by 28ft. 0¼in. to carry cargo. Engines, triple-expansion, 25in., 42in., 70in. by 48in. stroke; pressure, 200 lb. per square inch; constructed by the builders; trial trip, October 30th.

Dorothy Rose, steel screw steamer; built by D. and W. Henderson and Co., Ltd., to the order of Messrs. Richard. Hughes and Co.; dimensions, 250ft. by 37ft. by 18ft. 6in. Engines, triple-expansion, 19in., 31in., and 52in. by 36in. stroke; pressure, 180 lb. per square inch; constructed by the builders; launch, October 31st.

Dunbar Castle, twin-screw motor vessel; built by Harland and Wolff, Ltd.; to the order of Union Castle Mail Steamship Company, Ltd.; dimensions, 470ft. by 61ft. by 35ft. 3in.; to carry passengers and cargo. Engines Harland-B. and W. type of Diesel engines; constructed by the builders; launch, October 31st.

Tuscan Star, twin-screw motor vessel; built by Palmers Shipbuilding and Iron Company, Ltd., to the order of Blue Star Line (1920), Ltd. Engines, Sulzer Diesel; constructed by the builders; launch, October 31st.